POWER

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Cumulative Progress

THERE has just been celebrated in France the one hundredth anniversary of the invention of photography.

Joseph Nicéphore Niepce was interested in the lithographic process of printing. He conceived the idea of covering tin with a composition sensitive to light on which he placed his designs and made light and chemistry do the carving. The light was admitted through a hole in a box.

Louis Daguerre, working with Niepce, developed the apparatus into a camera, fixing upon a plate an impression of that upon which it was focused instead of producing a pattern laid upon the sensitive surface.

And the faces of a past generation are preserved to us in the daguerreotype, in which they may be "seen as in a glass dimly."

Used for a long time simply for making portraits and views, see what it has led to! The motion picture with all its possibilities not only for amusement and education, but, in the hands of the scientist, for the study of motions imperceptibly slow by speeding them up or the fixing of motions imperceptibly swift.

It has made visible the action of light rays in the ultra violet, with frequencies above the capacity of the human retina to record, and made possible the revelations of spectroscopy.

It has enabled man to partly answer the challenge to "number the stars in the heavens" and to determine their movements and distances.

It has enabled the surgeon or physician to look into the maimed or affected body and work with assurance, where he formerly guessed and groped in the dark.

It has enabled the engineer to detect with the X ray defects lurking in the interior of castings.

It has revealed to the physicist the composite structure of the atom and traced the flight of particles that no microscope could reveal, moving at velocities of thousands of feet per second.

It has made possible all the wonderful processes of photo engraving whereby the old laborious woodcut or etching is replaced by engravings picturing events within an hour of their occurrence with all the fidelity of a photograph, and whereby paintings and natural scenery are reproduced in all their natural colors.

It has made it possible to send pictures across the continent on a wire as one would telegrams. Pictures of the recent earthquake in California were on the street in New York papers within a few hours after the shock occurred.

And how simple it all was!

A man noticed that light has an effect upon some substances. He coated a sheet of tin with such a substance, shielded part of it from the light by covering it with a pattern, exposed the rest, treated it in its altered condition and made a plate that would print.

Another man, knowing the principle of the camera obscura, realizes that the light and shadow of the picture projected by the lens would have the same effect as that produced by the cut-out pattern, makes upon the plate a visible and lasting reproduction of that view.

And neither of them suspected its possibilities, and we are only just finding them out.

Thus does one invention open the door to others. Daguerre started the train that led to the dissection of the atom. The clerk that idly rubbed a stick of sealing wax and watched it attract bits of paper, held in his hand the key to the Electric Age if he had but known it.

F. R. Low

A Practical System for Handling Mechanical Department Job Orders

By H. F. SCOTT
Plant Engineer, Dennison Manufacturing Company

PLANT engineering in industrial plants is a development that has become an important function of manufacturing during recent years. The plant engineer today is one of the management group, and his duties may lie anywhere in the range between the master mechanic of the old days and general manager. His official position in any particular plant depends largely upon the nature of the product and the extent to which engineering practice enters into the operation of the plant, with regard to both the physical properties and production. Power-plant operation, care of buildings and equipment for power, light and heat, combined in most cases with maintenance of manufacturing equipment, cover a broad range of engineering and often require several departments to perform work that cannot be sent outside to advantage. Frequently, plant engineering also includes construction work and development of facilities for manufacturing the product, provided they can be economically taken care of with the engineering staff that is maintained.

AS PLANT engineer for the Dennison Manufacturing Co., Framingham, Mass., the author is responsible not only for power, light, heat and process steam, but also for the maintenance of all buildings and equipment for manufacturing purposes. On the average, 175 work orders are received daily, covering everything from stopping a steam leak to installing a large machine. This article describes a simple system by which these orders are followed up with a minimum of red tape and effort. Here is an idea of practical merit for the plant engineer buried in a flood of details.

The variety of problems and the infrequent repetition of jobs do not permit a highly developed order system in the engineering department, but any practical system must provide for a means of following deliveries, making estimates and distributing costs, and it must include such planning as may be required.

The order system described in the following paragraphs suggest a means of providing for the features just mentioned. Its simplicity, combined with the fact that the work order itself is the vehicle that provides the system with perpetual and visible records of performance, makes a very desirable combination. The operation of any order system that requires a separate operation to record the progress of work frequently breaks down when the novelty is worn off, and it also involves additional expense.

The basis of this order system is immediate service on emergency orders, prompt service on all small orders, the follow-up of all promised orders, and a scheduled delivery on all large orders or orders of any degree of importance, provided the delivery runs over a predetermined period. Such planning and requisitioning of materials and parts as is necessary may be done previous to entering the orders or after the orders are entered, if they are referred to a planning group to study into the details. On large work individual sub-orders are made out for each operation and delivery.

Orders sent to the engineering department are made out by manufacturing departments or by authorized persons connected with maintenance or construction work. These are sent in duplicate to the mechanical department order clerk, who numbers them consecutively as received, regardless of which department is doing the work. The order clerk sees that the order is marked for the proper mechanical department and that it carries all necessary information showing what work is to be done and to what account the order is to be charged. Emergency orders may be received over the telephone and are written in duplicate by the clerk, and both copies are stamped to show that they are emergency orders. The duplicate copy is sent by special messenger or by some rapid delivery service to the mechanical department that is to perform the work, and the original copy is filed by the order clerk.

The most important feature of this system is the method of filing orders while they are in process. A tub desk is employed with twelve trays, each one divided by metal partitions into twenty-five or more compartments. The compartments of several of the trays are designated with the number or name of the manufacturing department issuing the orders, and each tray has a removable index attached at the end showing the series of numbers contained in the tray, preferably 100 orders. It is not difficult for the clerk to locate an order during the earlier period of its progress if he knows which manufacturing department has issued it, and while the order might occur in several of the trays, if he knows approximately when it is placed, the proper tray can be quickly located.

When the orders total 100 in the tray that is receiving the incoming orders, the last tray in the first series is removed and what orders remain are taken out. The empty tray is then put at the head of the line and the trays are all moved along one place.

The most important duty of the order clerk is to follow the progress of the work, and he is immediately informed when the work on any order is completed by

the return of the duplicate order from the mechanical department, together with a time card and material sheet. He immediately removes from the tub desk the original order, attaches the duplicate and the time card to it, and turns it over to the cost clerk. When these trays are moved along one after another, the number of orders in the tray grows less and less until in the last tray there are very few left at the end of the period which can be provided for. For instance, if an average of 200 orders is going through each day, eight trays would provide for four days' work.

Several times a day the order clerk should look over the second or third trays to see that no emergency orders are left uncompleted. He should also carefully analyze all those removed from the last tray, and if glance whether the larger volume of orders, which generally includes the small ones, is being completed rapidly. For instance, if the last of the removable trays contains many orders, it is apparent that the emergency orders and many of the small orders are not being completed within a short period, or it might show that a great many large orders were going through.

The number of orders ahead of each mechanical department in the tray containing old orders shows the amount of scheduled work ahead of each department. After one becomes familiar with this plan, a glance at these trays and a close observation of the number of orders in the trays give a clear idea of the situation. Hold orders are kept in separate trays and may be

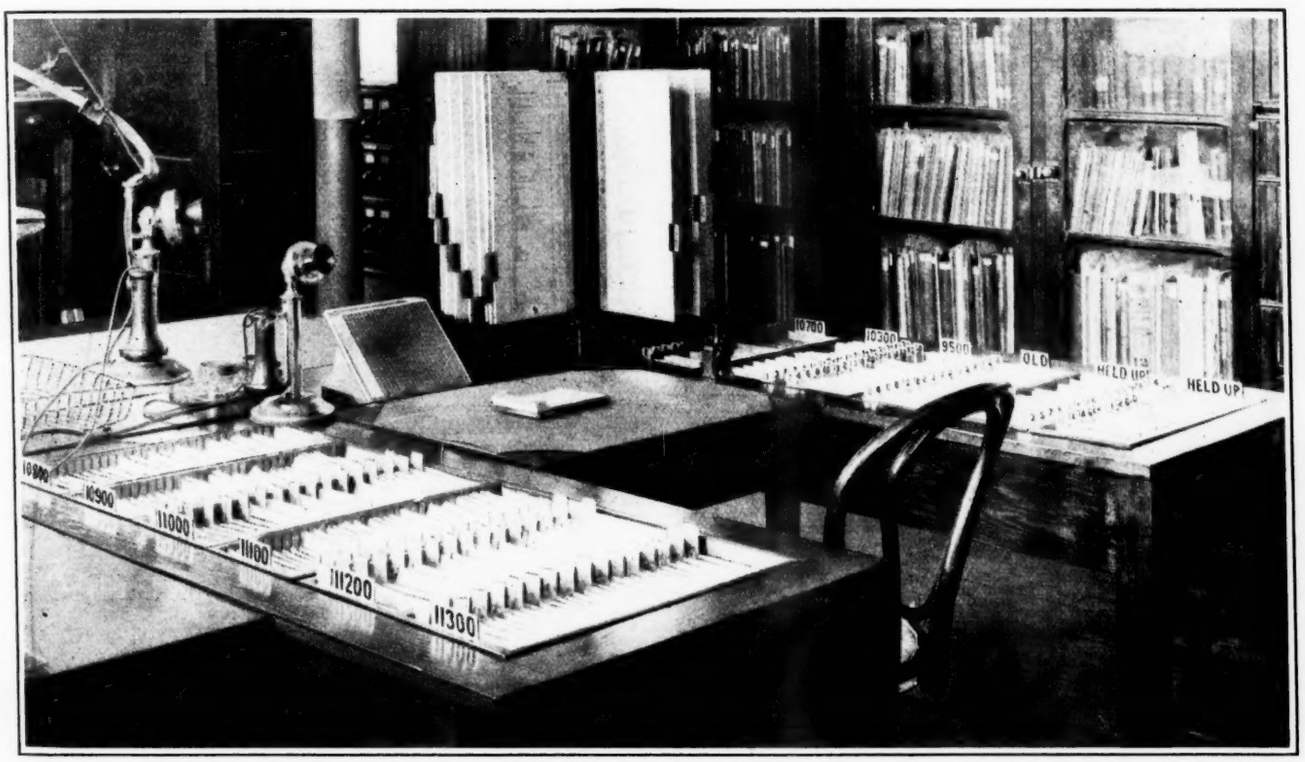


Fig. 1—Incoming order slips are filed in tray 11,300 and in the compartment bearing the number of the manufacturing department issuing the order. When 100 orders have been placed in tray 11,300, all trays will be shifted along one place to make room for tray 11,400

the system requires two order clerks these orders should be turned over to the second clerk, who will check the date if the work is to be completed at any specified time, and if no date is on the order he obtains a promise from the mechanical department that is to do the work.

The filing system for the original orders from this point on is somewhat different from the first file. Here orders are filled numerically and the orders for each mechanical department that performs the work are kept together. Most orders at this stage of progress are referred to entirely by numbers, as they are generally sub-orders connected with large work and often involve several different mechanical departments.

The visible record of progress we mentioned earlier in this description. The appearance of the tub desk, where the trays start with 100 orders, which are removed as fast as the work is completed, shows at a numbered or not, depending upon whether the order has been entered or the work has been stopped temporarily.

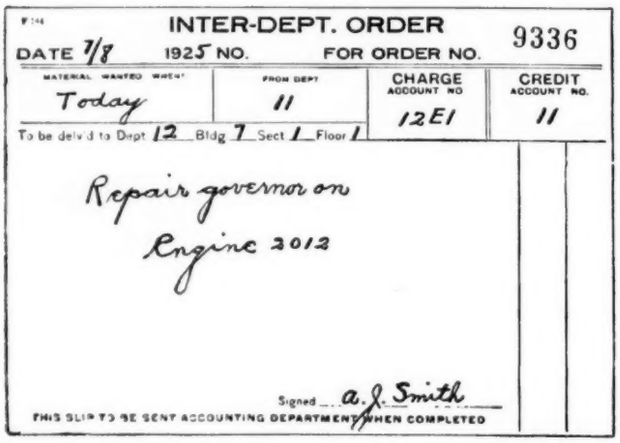
The illustration shows the system when it is being operated with one order clerk, and nine trays are in use allowing for a period of about five days. The average number of orders is about 175 per day.

The tenth tray is used for the orders removed from the first group of nine trays, and the eleventh and twelfth trays are for filing of hold orders.

The system, when operated with two order clerks, can easily include the following up of outside purchases and co-ordinate the work with material that is received from outside the factory. Other contacts may be provided for, depending upon the average number of orders going through the mechanical department and the number of order clerks who are employed to work this system. In the illustration the vertical index above

the order clerk's desk is for quick reference, to check machine numbers and locations in the factory and power plant, as each machine, motor and controller bears a machine number.

The writer would not presume to claim that this is a highly developed order system, but it is a condensed system, gives good service and has worked out well in practice. Most plant engineers find by experience that if emergency work and small orders are taken


F-14

INTER-DEPT. ORDER 9336

DATE 7/8 1925 NO. FOR ORDER NO.

MATERIAL WANTED WHEN	FROM DEPT	CHARGE ACCOUNT NO	CREDIT ACCOUNT NO.
Today	11	12E1	11

To be deliv'd to Dept 12 Bldg 7 Sect 1 Floor 1

Repair governor on Engine 2012

Signed a. J. Smith

THIS SLIP TO BE SENT ACCOUNTING DEPARTMENT WHEN COMPLETED

Fig. 2—Sample of repair order ready for tub desk

The great majority of such orders are automatically cleaned up before the lapse of a week or less brings the tray to the end of the line. The few orders remaining in the tray can then be given special attention. This system avoids waste of time in scheduling trivial jobs.

care of promptly, the larger orders can be handled to the satisfaction of everybody.

With this system planning methods can be carried out to any extent desired and planning of small orders can be left to the foremen of the departments doing the work, or in manufacturing plants where many of the maintenance men become specialists, it can be left to the workman himself. It would not be easy to lay down any one system that would apply to the mechanical departments in all industries, but the essential features of the plan described may suggest a simple way to provide for this important function of plant engineering.

The Over-all Economy of Diesel Engines*

By C. B. Jahnke†

IT IS generally admitted and understood by all engineers that the Diesel oil engine is thermodynamically the most efficient prime mover yet developed. The experience of twenty-five years has proved that, with respect to reliability and dependability, it is second to no other form of mechanical power. It remains to be shown that its over-all efficiency, taking into account the investment and operating costs, merits the serious thought of power users when considering replacing steam and electric-motor driven plants and in planning for additional power units.

*Extract of paper read before the New England Waterworks Association.

†Chief engineer, Fairbanks, Morse & Co.

It is rather difficult to secure a great number of reliable operating figures on small municipal plants owing to the fact that in many cases complete operating records are not kept, or if most of the items are recorded, some one important factor will be entirely overlooked so that it is impossible to draw definite conclusions. It has been endeavored to secure as many reliable records as possible, and as a result of that investigation, we are able to show some detailed costs

TABLE I—LOCATION AND EQUIPMENT OF TWENTY-NINE OIL ENGINE DRIVEN PLANTS WHICH WERE ANALYZED

1. New England, No. Dak. Municipal elec. light and power. One 50-hp. oil engine d.c. to a 40 kva. 2,300-v. alternator; one 100-hp. d.c. to 75 kva. 2,300-v. alternator.
2. Dakota Utilities Co., Eureka, So. Dak. Central station. One 100-hp. d.c. to a 72-kva. alternator; one 50-hp. belted to a 30-kva. alternator; one 25-hp. belted to a 20-kva. alternator.
3. Pender, Neb. Municipal light and plant. One 100-hp. d.c. to a 75-kva. three-phase, 60-cycle, 2,300-v. alternator; one 150-hp. d.c. to a 125-kva. alternator.
4. Oakland, Neb. Municipal pumping plant. One 50-hp. belted to three deep well pumps and to an 8x10-in. triplex pump.
5. Storm Lake, Iowa, Municipal pumping plant. One 37½-hp. geared to 10x12-in. triplex pump and belted to a 6-in. centrifugal.
6. Perry, Iowa. Municipal pumping plant. Two 100-hp. d.c. to a 60-kva. 2-phase, 60-cycle, 2,300-v. alternators.
7. Bancroft, Neb. Municipal light and plant. Two 50-hp. belted to 37½-kva. 3-phase, 60-cycle, 2,300-v. alternator.
8. Emerson, Neb. Municipal light plant. One 37½-hp. belted to 25-kw. alternator; one 50-hp. belted to 37½-kw. alternator; one 150-hp. d.c. to a 125-kva. alternator. Alternators 3-phase 60-cycle, 2,300-v.
9. Natchitoches, La. Municipal pumping plant. Two 150-hp. d.c. to 125-kva. 3-phase 60-cycle 2,300-v. alternators and clutch connected to 750 g.p.m. duplex power pumps.
10. Gallipolis, Ohio. Municipal pumping plant. One 100-hp. belted to a 11x14-in. triplex pump running at 42 r.p.m.
11. Watsonville Ice & Cold Storage Co., Watsonville, Calif. One 50-hp. belted to a 25-ton ammonia compressor.
12. James Rosenberg, San Ardo, Calif. Irrigation plant. One 100-hp. belted to a 5,400 g.p.m. centrifugal pump.
13. Quincy, Mich. Municipal pumping plant. One 100-hp. d.c. to a 75-kva. and one 200-hp. d.c. to a 170-kva. 2-phase 60-cycle 1,150-v. alternator and to centrifugal pumps.
14. Santa Cruz, Calif. Municipal pumping plant. One 100-hp. and one 150-hp. belted to centrifugal pumps.
15. Madill, Okla. Municipal pumping plant. One 75-hp. d.c. to a 9x12-in. single-acting triplex pump and one 75-hp. d.c. to a 9x12-in. triplex and a 5x5-in. single-stage air compressor.
16. Fayetteville, Ark. Water Improvement District No. 1. One 150-hp. clutch connected to a 10x16-in. triplex pump.
17. Strawn, Tex. Municipal light plant. Two 50-hp. d.c. to 40-kva. alternators and one 150-hp. d.c. to a 125-kva. alternator.
18. Roodhouse, Ill. Roodhouse Water Corporation. One 75-hp. d.c. to a 11x12-in. triplex pump.
19. Terrell, Tex. Municipal light plant. Three 200-hp. d.c. to 170-kva. generators and one 300-hp. d.c. to a 250-kva. alternator.
20. Garland, Tex. Municipal light plant. Two 100-hp. d.c. to 75-kva. alternators and one 150-hp. d.c. to a 125-kva. alternator.
21. Nicholasville, Ky. Municipal pumping. One 100-hp. d.c. to a 7x12-in. 450-g.p.m. duplex pump and belted to a 14x9-in. compressor.
22. Stonewall, Okla. Municipal light plant. Two 50-hp. d.c. to 40-kva. 3-phase 60-cycle 2,300-v. alternators.
23. Vinal Haven, Me. Vinal Haven Elec. Light & Power Co. One 50-hp. d.c. to a 32-kva. and one 25-hp. belted to a 16-kv. alternator.
24. Covington, Tenn. Municipal light plant. One 100-hp. d.c. to a 75-kva.; one 200-hp. d.c. to a 170-kva. and one 300-hp. d.c. to a 250-kva. 3-phase 60-cycle 2,300-v. alternator.
25. Charleston, Miss. Municipal water and light plant. One 100-hp. d.c. to a 75-kva. and one 200-hp. d.c. to a 170-kva. alternator.
26. Crystal Falls, Tex. Walker Caldwell Water Co. One 50-hp. belted to a 625-g.p.m. centrifugal pump and one 100-hp. d.c. to a 1,000-g.p.m. centrifugal pump.
27. Newton, Miss. Municipal light and water plant. One 50-hp. d.c. to a 40-kva. alternator and to a fire pump, one 100-hp. to a 75-kva. alternator and to a fire pump and one 150-hp. d.c. to a 125-kva. alternator.

(In the above d.c. denotes "direct connected")

on the operation of twenty-nine plants in municipal light and power service. These records are perhaps not the best that could be secured, but they probably represent average practice for the small municipal plant and for that reason can be safely compared with the average small plant operating with steam or purchased power.

Table I shows the principal equipment contained in these twenty-nine stations and gives the class of service. It will be noticed that fourteen are operated as electric light and power plants and the others are classed as pumping stations.

An important item in the operation of a power or pumping plant is the operating labor required. This labor cost is partly dependent on the yearly load factor of the plant and on the number of units installed. It naturally follows that a plant that operates sixteen

hours out of the day will require more operating expense than one that operates eight hours a day, and it also follows that a plant containing three or four units will require more care and, therefore, more expense than a single-unit plant.

TABLE II—OPERATING LABOR COSTS IN OIL ENGINE PLANTS OF TABLE

Plant No.	No. Units	Total Hp.	Hours Service per Day	Total Engine Hours per Year, All Units	Number Attendants	Total Labor Cost Dollars	Location
1	2	150	24	7,552	2	3,000	N. D.
2	3	175	24	11,315	3	3,900	S. D.
3	2	250	24	.....	3	4,800	Neb.
4	1	50	10	3,650	1	2,160	Neb.
5	1	37½	14	4,750	1	1,620	Ia.
6	2	200	24	8,800	3	3,440	Ia.
7	2	100	24	8,395	2	2,400	Neb.
8	3	237½	24	10,030	3	4,320	Neb.
9	2	300	24	8,459	3	4,320	La.
10	1	100	12	4,380	1	1,900	Ohio
11	1	50	24	8,010	1*	1,200	Cal.
13	2	300	24	8,760	3	4,440	Mich.
14	2	250	24	6,200	3	2,270	Cal.
15	2	150	8	2,920	1	1,200	Okla.
16	1	150	24	6,570	2	1,740	Ark.
17	3	250	24	14,620	3	4,800	Tex.
18	1	75	..	.....	2	3,000	Ill.
19	4	900	24	.....	4	5,760	Tex.
20	3	350	24	.....	2	2,820	Tex.
21	1	100	8	2,920	1	900	Ky.
22	2	100	24	10,220	2	2,400	Okla.
23	2	75	10	4,350	2	2,500	Maine
24	3	600	24	5,760	3	2,310	Tenn.
25	2	300	24	12,000	2	2,010	Miss.
26	2	150	24	5,923	2	3,206	Tex.
27	3	300	24	12,720	2	2,300	Miss.

*One man on each shift operates ice plant.

TABLE III—AN ANALYSIS OF REPAIR COSTS IN THE OIL ENGINE PLANTS OF TABLE I

Plant No.	No. Units	Total Hp.	Years' Service	Total Cost Engine Repairs, Dollars	Extra Labor Cost, Dollars	Repairs per Unit Prod., Dollars
1	2	150	1½	.....	.....	.....
2	3	175	8	2,506.00	.....	0.00024
3	2	250	1	.....	.....	.....
4	1	50	2	0.84	.....	.....
5	1	37½	3	.....	.....	.....
6	2	200	1	.....	.....	.....
7	2	100	6	1,007.68	.....	0.00016
8	3	237½	5	980.88	40.00	.....
9	2	300	4	150.00	.....	.....
10	1	100	1½	65.00	50.00	.....
11	1	50	10	265.00	.....	.....
12	1	100	4	.....	.....	.....
13	2	300	4	785.00	.....	0.0005
14	2	250	8	368.00	.....	.....
15	2	150	4	51.51	50.00	.....
16	1	150	1½	.....	.....	.....
17	3	250	10	6,293.00*	.....	0.0012
18	1	75	3	249.03	.....	.....
19	4	900	2	605.15	.....	0.00024
20	3	350	1	.....	.....	.....
21	1	100	1	.....	.....	.....
22	2	100	6	750.00	.....	.....
23	2	75	6	1,554.12	.....	.....
24	3	600	1	.....	.....	.....
25	2	300	1	21.65	.....	.....
26	2	150	4	527.67	.....	.....
27	3	300	4	308.46	.....	0.00027
28	2	400	2	414.90	523.98	.....
29	1	100	3	54.04	.....	.....

* Crankshaft.

Labor costs, of course, depend somewhat on geographical location, and there will be some variation in different plants for that reason. It will be noted, however, that it would hardly be possible to reduce any of these labor charges as in many cases the single-unit plants are operated by one man, and even the three-unit plants require only three men when operated on a twenty-five hour basis, or one man per shift. These figures, therefore, tend to disprove the contention of the advocates of motor drive, that the cost of labor is higher on the oil-engine plant than it is on the motor-operated plant. One man has to be kept on the job regardless of the type of plant, and it is evident from these figures that one man can handle an oil-engine plant of considerable size.

On account of its fairly high first cost, it has been claimed that the fixed charges on a Diesel engine are

TABLE IV—OPERATING COSTS OF THE OIL-ENGINE DRIVEN ELECTRIC PLANTS OF TABLE

Plant No.	Load Factor—Running Per Cent	Load Factor—Yearly Per Cent	Kw.-Hr. Produced per Year	Operating Cost—Total	Operating Cost—Unit	Total Investment	Fixed Charge Cost—Total	Fixed Charge Cost—Unit	Unit Fuel and Lubr. Oil Cost	Unit Total Cost with Fixed Charges
1	37½	15	113,605	$4,929	$0.0434	$19,800	$1,980	$0.0174	$0.016	$0.0608
2	42	18	165,050	6,787	.0411	36,300	3,630	.0220	.0147	.0631
6	82	41	430,000	7,320	.0170	30,000	3,000	.0070	.0066	.0240
7	48	23	120,000	4,080	.0340	18,200	1,820	.0152	.0140	.0490
13	52	36	403,000	8,497	.0210	41,000	4,100	.0102	.0094	.0312
17	58	37	481,800	10,309	.0214	34,400	3,440	.0071	.0079	.0285
19	...	36	1,271,400	15,224	.0120	74,400	7,440	.0058	.0074	.0178
24	57	21	650,000	10,236	.0157	92,000	9,200	.0141	.008	.0298
27	38	23	365,000	5,648	.0155	54,000	5,400	.0148	.009	.0303
Average					$0.246			$0.0124	$0.0103	

TABLE VI—OPERATING COSTS OF THE OIL ENGINE PUMPING PLANTS OF TABLE I COMPARED WITH STEAM AND MOTOR DRIVEN PLANTS

Plant	No. of Pumps	Gallons Pumped, Millions	Static Head	Operating Cost Except Fuel and Lub. Oil	Cost per Million Gal., Cents	Fuel and Lub. Oil	Fuel and Lub. Oil per Million Gal., Cents	Total Operating Costs per Million Gal., Cents	Fuel and Lub. Oil Cost Corrected for 150-Ft. Head, Cents	Total Operating Costs on Basis of 150 Ft. Head, Cents	Price of Fuel Oil Coal Current, Cents per Gal.
5	2	142	150	$1,805	12.72	$1,505	10.60	23.32	11.12	23.84	11.9
10	1	163.3	322	2,115	12.92	1,532	9.38	22.30	4.37	17.29	6.47
15	2	87.6	402	1,260	14.38	619	7.07	21.45	2.64	17.02	4.0
16	1	222	402	2,040	9.20	2,568	11.55	20.75	4.32	13.52	6.02
26	2	262.1	200	4,046	15.41	1,457	5.56	20.97	4.17	19.58	3.57
Steam Pumping Plant Costs											Dollars per Ton
Marinette	4	617	150	4,142	6.70	15,806	25.60	32.30	25.60	32.30	6.72
La Crosse	8	1,213	240	18,780	15.45	19,419	16.00	31.45	10.00	25.45	6.89
Berlin	2	77.4	135	4,066	52.70	2,093	27.10	79.80	30.50	83.20	7.00
Washburn	2	155.8	250	2,840	18.25	6,186	39.75	58.00	23.80	42.05	9.33
Janesville	4	589	175	6,760	11.45	7,405	12.55	24.00	10.75	22.20	6.04
Kenosha	5	1,670	162	17,491	10.45	19,816	11.85	22.30	10.97	21.42	7.60
So. Milwaukee	6	317	210	11,536	36.50	11,847	37.40	73.90	26.70	63.20	7.60
Motor-Driven Pumping Plant Costs							Current Costs				Cents per Kw.-Hr.
Menominee	2	170	240	3,361	19.80	5,633	33.10	52.90	20.70	40.50	1.25
Delavan	3	244.3	125	3,560	145.80	1,378	56.60	202.40	68.00	213.80	3.0
Columbus	2	466.5	135	767	16.50	1,573	34.80	51.30	38.70	55.20	3.5
Castleton	1	146.7	223	1,374	93.50	1,533	104.20	197.70	70.40	163.90	4.5
Neenah	3	177	110	3,642	20.60	8,246	46.50	67.10	39.40	60.00	
Wisc. Rapids	4	214	195	2,619	12.20	5,034	23.50	35.70	18.05	30.25	2.44
Chippewa Falls	4	371.6	185	2,471	6.65	6,475	17.40	24.05	14.10	20.75	1.44
Lake Geneva	4	608.7	186	3,531	58.00	4,132	67.80	125.80	54.70	102.70	3.0
Stoughton	3	150.4	185	2,904	19.35	3,190	21.20	40.55	17.20	36.55	2.0
Waukesha	8	536.6	150	7,133	13.28	18,494	34.50	47.78	34.50	47.78	2.39

Note:—Motor and steam plant costs from Railroad Commission, State of Wisconsin.

necessarily extremely high. A good oil engine maintained in regard to the wearing elements will last indefinitely. Experience indicates that the parts that require care and maintenance are common to all prime movers. Records available through the British Diesel Engine Users' Association and American records obtained during the last 20 years indicate that useful life of a modern Diesel engine can, with the utmost safety and conservatism, be set at 25 years. The obsolescence figure in depreciation of the Diesel engine is negligible. It is extremely essential that the amount of actual depreciation be most carefully determined.

Since the total yearly interest on the cash outlay becomes less each year as the amount originally invested is reduced by the yearly depreciation, fixed detailed percentage rates cannot justly be assumed. Arbitrary rates of fixed charges including interest, depreciation and insurance have often been set as high as 13 to 15 per cent.

TABLE V—RELIABILITY AND DEPENDABILITY OF THE OIL-ENGINE PLANTS IN TABLE I

Plant No.	Years' Service	No. Units	Plant Shut Down, Due to Engines, Hours	Number of Failures to Start Promptly	Longest Continuous Run of Any Engine, Hours
1	1½	2	.....	..	90
2	8	3	.....	..	144
3	1	2	3	..	1,350
4	2	1	1	2	16
5	3	1	.....	..	18
6	1	2	.....	..	85
7	6	2	1	..	21
8	5	3	1½	3	60
9	4	2	.....	..	144
10	1½	1	.....	..	144
11	10	1	321	..	2,324
12	4	1	.....	..	366
13	4	2	.....	..	656
14	8	2	.....	..	1,440
15	4	2	.....	..	18
16	1½	1	.....	..	18
17	10	3	.....	..	18
18	3	1	.....	..	16
19	2	4	10 min.	..	48
20	1	3	15 min.	..	48
21	1	1	.....	..	492
22	6	2	.....	..	24
23	6	2	.....	..	164
24	1	2	.....	..	120
25	1	2	20 min.	..	2,160
26	4	2	.....	..	528
27	4	3	.....	..	3,360
28	2	2	48 min.	..	1,176
29	3	1	.....	..	216

It was impossible to obtain actual American operating data on steam and oil-engine pumping plants in comparable sizes, although Table II shows cost records for smaller plants. The operating costs for steam- and motor-driven pumping plants were taken from public records in the office of the Railroad Commission for the State of Wisconsin, at Madison. All the plants are operating in municipal service, have about the same yearly load factor, and operate under the same general service conditions. It is rather interesting to note the costs of pumping with purchased power in a state where development of both steam and water power has reached a fairly high plane.

Table III lists some very significant data on the subject of reliability and certainly establishes the fact that the Diesel engine is a most reliable prime mover. Diesel engines are coming into general use as stand-by units in hydro-electric plants, on account of the ability of the Diesel to start immediately. Such dependability is essential in pumping plants for fire service.

Operating records are often unfair on account of average low running load factor and high peaks, necessitating large total plant capacity. There is a great benefit in using multiple units in Diesel-engine plants to meet such conditions efficiently and make possible the lowest unit operating costs. This condition is distinctive of Diesel engines and comprises a just advantage over steam, for small steam units are not efficient.

Notes on Elevator Equipment

By Warren Hilleary*

On drum-type elevator machines the counterweight cables are wound on the drum in the opposite direction to the hoisting cables, and the drum counterweights should be below the car counterweights. The weight of the car has a tendency to turn the drum in one direction. The drum-counterweight cables, being wound on the drum in a direction opposite to the car cables, have a tendency to turn the drum in the opposite direction. Hence, when the car starts upward, the drum counterweights assist the motor in revolving the drum, and when the car is descending the drum counterweights tend to retard the downward motion. The car counterweights have the effect of retarding the car's downward motion and assisting its upward motion.

It is general practice to make the counterweights equal in weight to the weight of the car plus 40 per cent of its rated load. Under this condition, with 40 per cent load in the car, the power required to hoist the car and its load would be about the same as that required to lower the car and its load. It is impossible, however, to so arrange the counterweighting as to balance the different loads carried by an elevator.

There are several ways of counterweighting. On some types the car and drum counterweights are independent of each other, on other types there are drum counterweights only, and on still others only car counterweights. In some installations, chains or cables connect from the car to a dead point in the hoistway, or from the car to the bottom of the counterweights. The object of using chains or cables from the car to counterweights, or car to a dead point in the shaft, is to counterbalance the weight lost or gained as the cables shorten or lengthen between the center of the overhead sheave or winding drum and the car connection. These compensating chains or cables also help to steady the car and make for smoother operation.

When inspecting the cables, if the drum on an overhead-type machine is close to the floor, it may be necessary for the inspector to use a mirror for examining the wearing sides of the cables. If more than six to eight wires are found broken in one lay of any one strand, it is advisable that all the cables in the set be replaced with new ones. It is not desirable to leave one or more of the old hoisting cables in place even though they have the appearance of being in good condition. The new cable after installation will stretch considerable and on this account would not carry its share of the load. The cable fastenings inside the drum are generally of a clamp type. These should be examined for loose nuts and to see that the clamps are snug against the drum.

For absolute pressures ranging from 100 to 500 lb. per sq.in., the density of steam may be roughly computed by multiplying the absolute pressure by 0.0022. Thus the weight of a cubic foot of steam at 135 lb. gage (150 lb. absolute) would be $150 \times 0.0022 = 0.33$ lb. per cu.ft. The steam tables give 0.332 lb. This rule is exact at 168 lb. absolute, the error increasing for higher or lower pressures. At 100 lb. absolute the formula gives 0.22 lb. per cu.ft. and the table 0.2258. At 500 lb. the formula gives 1.10 per cu.ft. and the table 1.08.

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Parallel Operation of D.-C. Generators —Compensated Types

Requirements for Operating Direct-Current Generators, Having Pole-Face Windings, in Parallel—Parallel Operation of Compensated-Type Generators With Simple Compound Machines—Three-Wire Generators Operated in Parallel

By C. LYNN

SINCE generators having a high internal voltage drop parallel easier than those in which the voltage drop is small, it is sometimes hard to secure good parallel operation with generators having compensating pole-face windings owing to the small inherent voltage drop in these machines. Being compensated, there is less demagnetization of the main fields by armature reaction and a much lighter series-field winding is required than in the case of a non-compensated generator. This means that the series-field resistance becomes a smaller percentage of the total resistance of the series field and equalizer circuit resistances. It is thus harder to obtain equal division of currents in the series fields of two generators, when the resistance of the series-field part of the equalized circuits is not the greater part of the resistances of these circuits.

Shifting the Brushes in Direction of Rotation

To overcome the foregoing difficulty, it is sometimes advantageous to shift the brush position slightly in the direction of rotation. This will cause the armature to demagnetize the fields slightly and give more internal drop to the generator. To keep the voltage regulation the same, it is necessary to shunt less current from the series field. Sometimes a bucking or differential series field is used on a generator to give it a drooping characteristic inside the equalizer connection. This

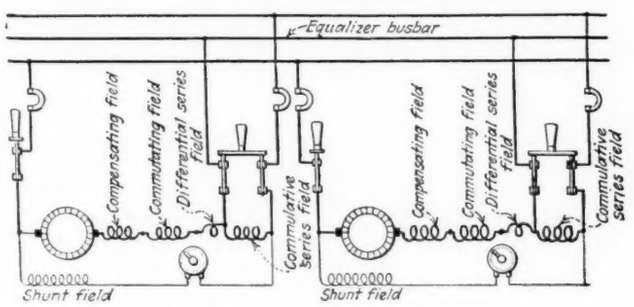

Fig. 1—Diagram of two compound-wound, commutating-pole compensated direct-current generators is parallel

consists of a light series-field winding connected between the regular or cumulative series field and the commutating-pole field, but connected so as to oppose the cumulative series field, Fig. 1. In order to give the same voltage regulation, an equivalent number of turns is added to the cumulative series-field winding. Note that the equalizer is always connected at the juncture between the cumulative-series and differential-series fields, as in the figure. Ordinarily, adjustment of the compounding is made by changing the shunt to the cumulative series field. The operation of machines of this type when in parallel, as in Fig. 1, is as follows:

If, for any reason, one generator tends to take more than its share of the total current, this extra current

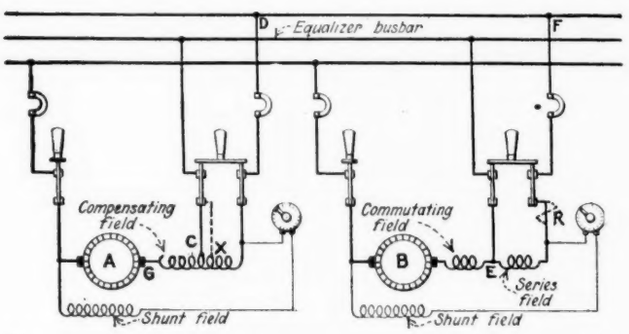

Fig. 2—Diagram of a generator having a compensating pole-face winding, connected in parallel with a machine of the compound type

divides at the equalizer juncture, the same as an ordinary compound-wound generator,[1] and part of this current goes through the series field of its own generator and the remainder goes through the series field of the other generator, thus raising the voltage of the latter and causing it to take some of the load from the generator taking more than its share of the load. Thus far the action is the same as in an ordinary compound-wound generator. However, since all the extra current in the overloaded generator passes through its differential series field and only a part of it passes through the cumulative series field, there will be a less increase in the compounding than if the differential series field were absent, which is the condition desired. Thus, in the case of compound-wound generators, with differential series-field windings operating in parallel, not only is the voltage of the underloaded generator raised, but the voltage of the overloaded generator tends to decrease when a condition or tendency of unbalance exists. Another advantage of the use of a differential series field is that its use, requiring additional turns on the cumulative series field, thus increases the resistance of the cumulative series field and gives better division of currents between the series fields of the generators in parallel.

Trouble is sometimes experienced in paralleling generators owing to the coarseness of the steps of the

[1] See article, "Parallel Operation of D.-C. Generators—Compound-Wound Type," June 16 issue.

rheostat. This is most often encountered in paralleling compensated generators where, by reason of the slight inherent drop in the machines, a small change in voltage causes a large shift in load from one generator to the other. In very pronounced cases it is sometimes necessary to use rheostats with finer steps of resistance in the vicinity of the operating position or install a vernier rheostat, which consists simply of a small rheostat with a few finely divided steps, which is connected in series with the regular rheostat, thus giving fine adjustment between the steps of the regular rheostat.

The paralleling of commutating-pole or even compensated generators with non-commutating pole, non-compensated generators can be accomplished if precautions are taken to make each generator fulfill the two requirements for successful parallel operation; namely, the generators must have aproximated the same

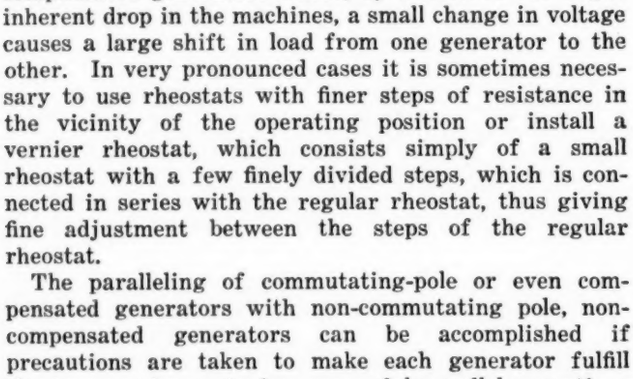

Fig. 3—Diagram of two three-wire generators connected in parallel

compounding or voltage regulation from no load to full load, and the voltage drop through the series-field windings and leads to the switchboard must be the same in all generators at full load. However, it may not be possible to secure as even a division of load between such generators as in the case of similarly designed generators, because it may be necessary, in the case of non-commutating pole generators, to shift the brushes forward with load to secure good commutation. Since this is almost always done by hand, at indefinite intervals, it results in a slight interchange of load currents between such machines, due to the effect upon the regulation curve of the non-commutating pole generator caused by the armature reaction upon the field when the brushes are shifted.

Special Types of Generators

There is a type of generator that differs from ordinary commutating-pole or compensated generators, in that it has compensating pole-face windings but no commutating poles or commutating-pole field windings as do ordinary generators. In place of the commutating poles laminated iron pieces are used, supported between the main poles by non-magnetic material. These magnetic pieces do not extend to the frame, but the commutating flux in them completes its circuit through the main pole tips. The compensating windings are wound around these pieces which function as interpoles, using the compensating winding as a commutating-pole field winding. Some of these generators do not have series-field windings, but make use of the compensating winding for this purpose. To do this a part of the compensating-field winding is wound eccentric in respect to the interpolar space. The direction of the eccentricity depends upon the direction of rotation of the generator. This gives the same effect, as regards compounding, as shifting the brushes off neutral, in an ordinary generator.

Since a shunt upon the compensating-field winding would have a bad effect upon the commutation, it is necessary to shift the brushes on this machine or adjust the speed regulation of the prime mover, if that is possible, in order to change the compounding. Sometimes this type of machine is built with a regular series-field winding in addition to the compensating-field winding, in which case the latter windings are made concentric as in the case of a standard commutating-pole compensated generator. Machines that operate in both directions of rotation are made in this manner, in order to get the same compounding or speed regulation when operating in either direction.

This latter type of generator is paralleled the same as any ordinary generator, and if all the conditions mentioned before, for successful parallel operation, are carried out, no difficulties will be experienced in paralleling one of these generators with an ordinary generator.

Connecting Compound-Wound and Compensated-Type Generators in Parallel

It is not difficult to parallel the non-commutating-pole compensated generator without a series-field winding with a regular type compound-wound generator, as in Fig. 2, if the voltage regulations of the two generators are alike and the voltage drop through the series field and leads of the ordinary generator, at full load, is made the same as the full-load voltage drop through the lead connected to the compensating winding and that portion of the compensating winding lying between the compensating winding lead and the equalizer of the other generator. That is, in Fig. 2, the voltage drop at full load is the same from *C* to D on generator *A* as it is from *E* to *F* on generator *B*. The compensating-field winding is so constructed that it is possible to move the point at which the equalizer is connected, to various points along the winding, these points being at the connectors between the poles where the windings are connected from pole to pole.

Suppose, in Fig. 2, that the two generators have the same voltage regulations from no load to full load, but that the standard generator takes most of the load. This means that the voltage drop at full load from *E* to *F* is less than that from *C* to *D*, thus causing most of the total current from both generators to flow through *EF*, thereby increasing the compounding of the standard generator and causing it to take more than its share of the total load. To make the voltage drop the same, a series resistance can be inserted at *R* in the lead from the standard generator, of such a value that at full load on each generator the voltage drops are the same. Another method is to move the position of the equalizer connection on the other generator, to some point *X*, such that the drop from *X* to *D* equals that of *E* to *F*, when each generator is carrying full load.

Making the Equalizer Connection

In order not to upset the commutation, the equalizer connection should be at such a place that not much more than 50 per cent of the total compensating winding be included between the point where the equalizer is attached and where the armature is con-

nected to the compensating field winding; that is, between points *X* and *G*. In case the standard generator has a very low series-field-circuit voltage drop, as in the case of a high-speed commutating-pole compensated generator, and the other generator has a high voltage drop, as in the case of a slow-speed engine-type generator, it is often advisable to insert some resistance at point *R* rather than bring point *X* too near point *D*, as that would leave too little of the compensating winding included in the equalizer circuit to be effective in securing good parallel operation.

Connecting Three-Wire Generators in Parallel

Sometimes generators are supplied with collector rings and balance coils for furnishing three-wire service, giving, say, 250 volts between the two outside wires and 125 volts between the neutral and either outside wire. When this type of generator is paralleled with a similar machine, the connections are as indicated in Fig. 3. It is necessary that the series fields and the commutating and compensating-field windings, if any, be split so that one-half of each of these fields is located on each side of the generator armature. This is necessary so that the generators will compound and commutate properly, whether the load is balanced or the total load the generator is carrying at any time is between the neutral and one of the outside lines, or divided in any proportion between these two sides. If the series-field windings were all on one side, this would not be the case.

In splitting up the series, commutating and compensating fields into two sections, one on each side of the armature, it is necessary that the fields of alternate poles be in series forming one side of the circuit; that is, all the south pole series fields should be connected in series on one side of the armature and all the north pole series fields be together on the other side of the armature. If this is the case, then, neglecting the leakage flux, all the poles will be magnetized alike, for assume that all the load is between the neutral and the line connected to the south pole series field, then the flux produced by the current flowing in these field coils must flow through the north poles of the generator in completing the circuit and thus magnetize the north poles the same as the south poles.

Since there are two series fields on these generators, there must be two equalizers connecting them together, as in Fig. 3, and all that has been stated before in paralleling two-wire generators applies to three-wire generators excepting that there are now two equalizers and series fields to deal with instead of one.

Three-Wire and Two-Wire Generators Connected in Parallel

When a three-wire generator has to parallel with a two-wire generator, it is necessary to reconnect the series, commutating and compensating fields, if any, of the two-wire generator, so that they are split into two parts as in the case of the three-wire generators. The paralleling connections are then the same as shown in Fig. 3 except there being no three-wire parts on one generator, the neutral lead will connect to one generator only, and all unbalanced load will have to be carried by the three-wire generator alone.

Where generators to be paralleled are located in stations a considerable distance apart, it is generally unnecessary to connect them together with an equalizer even if the generators are considerably overcompounded at their terminals. The voltage drop in the negative and positive leads is sufficient to give to the system a drooping voltage characteristic, and this gives good parallel operation to the system.

Shunt-wound generators inherently have drooping voltage-regulation curves and will parallel successfully. The regulation curves of different shunt-wound generators vary considerably, and the only way to make them alike is by shifting the brushes, in the case of commutating-pole generators, which changes the regulation curves, the same as in compound-wound generators. Another method is to insert a series resistor between the switchboard and generator of the machine with the best regulation curve so as to bring its regulation down to that of the other generator.

Most shunt-wound generators have regulation curves that are too drooping for use in supplying fluctuating industrial loads. They are generally used for exciters or for supplying power to electrolytic loads or such installations where the change of load is slow and the voltage can be controlled by hand manipulation of the field rheostats. In such cases correct division of load between machines in parallel can be secured by hand adjustment of the shunt-field rheostats.

How Slag Weakens Rolled Steel

It is well known that rolled steel or iron sheets or rods tend to be stronger lengthwise than crosswise. Some slag is practically always present. This tends to be rolled into sheets or streaks, thus separating the metal to some extent. There is little effect due to slag on the metal when pulled lengthwise (in the same direction as rolled), but the slag tends to produce natural weakness in the direction of thickness or distance from one roll to the other.

In a number of tests cited in a paper read before the Iron and Steel Institute, London, May 7, it was found that fatigue tests show little difference with regard to direction of the grain, but tensile strength in a longitudinal direction sometimes tested 15 per cent or more higher than at right angles to the grain.

At a recent meeting of one of the engineering societies a group of men were discussing the difficulties of bringing in an oil well. One of them told of a well that came in with the liberation of a large volume of gas. A small gasolene engine found the heavily charged atmosphere sufficiently rich to propel it, and ran away notwithstanding its governor had shut off its legitimate source of fuel supply. In an effort to stop it, the man in charge pulled the ignition switch, drew a spark and lighted the atmosphere. When those present came to and called the roll, they found everybody accounted for but one negro. Some twenty minutes later even he appeared. When asked where he had been he replied, "I been comin' back."

In an Orsat it is essential that the solutions for absorbing oxygen and carbon monoxide be protected from contact with fresh air by means of tight rubber bulbs or displacement bottles connected to the back branches of the pipettes. Contact with the air of the room will soon ruin these solutions. The caustic solution for absorbing CO_2 need not be so protected.

Boiler Plant of the Ludlum Steel Co. Watervliet, N. Y.

TWENTY-YEAR old boiler plant consisting of three 1,500-sq.ft. hand-fired return-tubular boilers replaced with two 3,080 sq. ft. water-tube boilers equipped with underfeed stokers. The boilers operate on widely fluctuating load. Multi-speed motor is used for stoker drive.

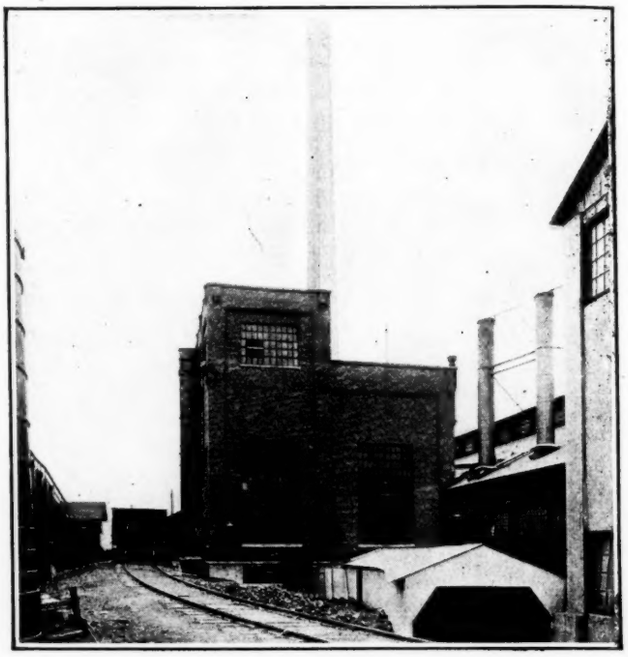

Fig. 1—General view of plant

IN 1923 the Ludlum Steel Co., Watervliet, N. Y., manufacturer of high-carbon and stainless steels, found it necessary to increase the capacity of its boiler plant to meet the demands of the shop for steam to operate the forging hammers.

The plant that was in use at that time was about twenty years old and consisted of three 1,500-sq.ft. return-tubular boilers hand-fired, with stationary grates and operating on natural draft, with a separate stack for each boiler. The boilers were set low, being only about 24 in. above the grate, consequently the efficiency was not high and it was possible to obtain but little more than normal rating.

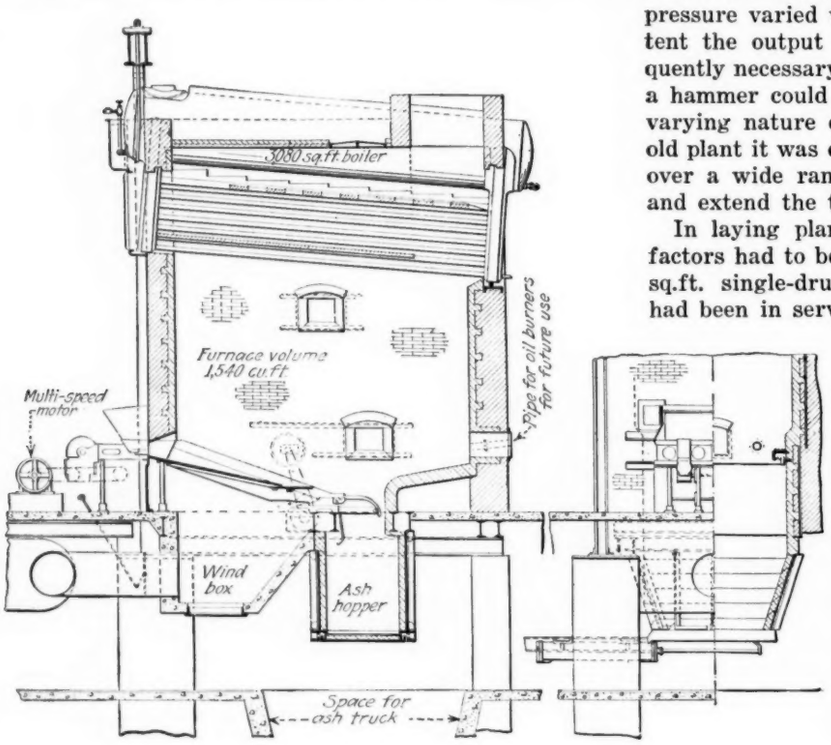

Fig. 2—Sections of boiler setting and furnace

Owing to the wide fluctuations in the steam demand, due to the intermittent use of the hammers, the steam pressure varied widely and this affected to a large extent the output of the hammer shop, as it was frequently necessary to wait for the pressure to rise before a hammer could be operated. In view of the extreme varying nature of the load and the inefficiency of the old plant it was decided to build a new boiler to operate over a wide range of ratings rather than to improve and extend the then existing installation.

In laying plans for the new plant certain existing factors had to be taken into consideration. Two 3,080-sq.ft. single-drum horizontal water-tube boilers that had been in service previously but not for about three years, were already on hand, and it was essential to utilize these in place of buying new boilers. As no authentic information was available as to the actual amount of steam required, it was essentially a problem of setting the boilers and equipping the plant to operate from 50 to 250 per cent of rating. This necessitated having the volume of the combustion chamber approximately the right proportion to the heating surface and pounds of fuel to be burned per hour, to operate the boilers at the required ratings, and design the stack for the maximum rating.

In view of the generally satisfactory performance of the underfed stoker operating with forced draft and its ability to respond readily to wide variation in steam demand, this type of equipment was selected.

The boilers were set to give a high furnace, the lower row of tubes being approximately 10 ft. 6 in. above the center line of the stoker retort. This gave a furnace

volume of 1,540 cu.ft., or a ratio of square feet of heating surface to cubic feet of combustion space of 2 to 1.

The general layout of the setting is shown in the cross-sectional view, Fig. 2. The stoker, which is a four-retort with grate area of 38.5 sq.ft., occupies about two-thirds the length of the furnace bottom, the remainder being made up by a low bridge wall and a composition floor extending from the stoker dump to the rear wall of the furnace. Stationary tuyeres are placed along each side wall at grate level to lessen the clinker troubles and damage to the side-wall lining.

The ashes and clinker as discharged by the stoker dump fall into a steel-plate tile-lined ash hopper suspended from the I-beam supporting the stoker and furnace bottom, the hoppers being fitted with steam-operated ash gates. The ashes are removed from the plant by motor truck, a runway being made in the basement floor as seen in the section, Fig. 2, to permit a truck being run under the ash hopper.

To supply the air for combustion, one 18,000-cu.ft. per min. motor-driven multi-vane fan is located in the basement and discharges into a common duct supplying both boilers. The fan runs at constant speed, and is capable of maintaining a static pressure of 5 in., if required, at the fan discharge. The air to each furnace is controlled by dampers operated by hand from the operating floor.

Where a stoker is required to operate on a widely varying load, it is essential that some means be provided for operating it at various speeds so that the fuel bed may be readily controlled for any particular rating on the boiler. In this particular case this is done with a multi-speed induction motor, having the winding of the stator so arranged that it can be grouped by operating the pole changer *A*, Fig, 3, for 6, 9, 12 and 18 poles, giving speeds of 1,200, 800, 600 and 400 r.p.m. This wide range of speed is further augmented by a two-speed gear box on the stoker. The drive from the motor to the stokers is made through silent and roller chains and a countershaft hung from the stoker retorts.

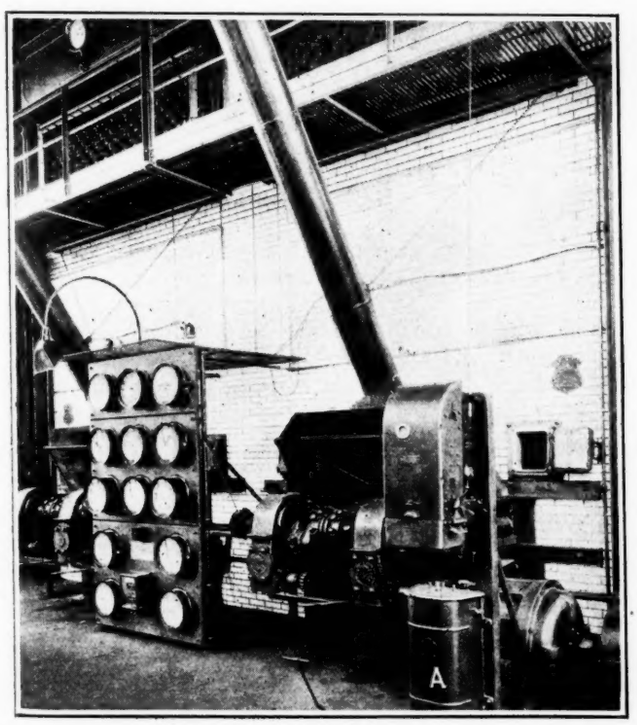

Fig. 3—Boiler instrument board and stoker drive

It might seem that inasmuch as the boilers operated on a fluctuating load an automatic combustion control might have been employed advantageously. The different controls available at that time were given due consideration, but it was realized that owing to the nature of the load and the character of the fuel burned, irregularities in the fuel bed would develop and require considerable readjustment. Also, there would be times when coal would have to be fed to the furnace with reduced draft in order to build up the fire to meet certain loads. In view of the wide variation in the load and the fact that there were only two boilers, it was considered that best results would be obtained through manual control of the air and fuel.

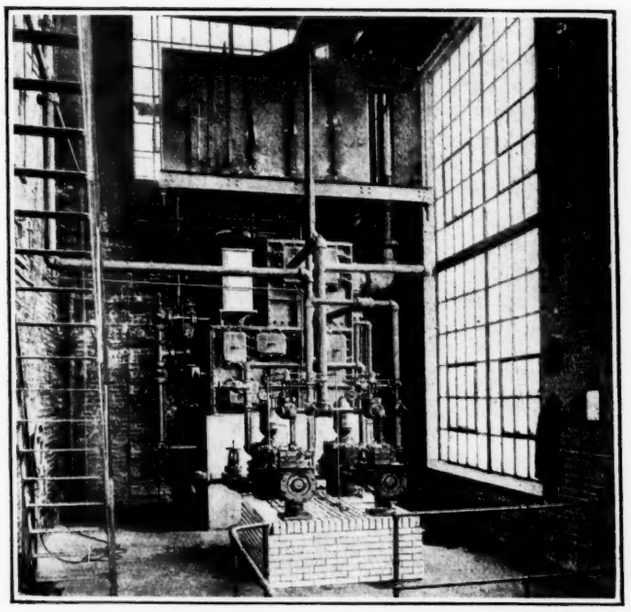

Fig. 4—Arrangement of heater and feed pumps

To assist the stokermen in operating the boilers, all the recording gages essential to intelligent operation are grouped on one board located between the stokers in plain view of the fireman. These gages include recording steam pressure, feed-water temperature, three-pen draft gages and gas temperature in the last pass of the boilers. The wattmeter in the center at the bottom of the board integrates the power used to drive the stokers and fans and other motor-driven auxiliaries in the plant, also the lighting.

As a means of advising the stokerman of a considerable increase to be made in the steam demand, four lamps, two white and two green, are placed directly above the instrument board. These are connected in series with a buzzer and push button in the hammer shop. By pushing the button in the shop the foreman can notify the stokerman that certain hammers are about to be used and the stokerman in turn presses a button on the board which automatically stops the buzzer and lets the man in the hammer shop know that the signal has been received.

The coal as received is dumped into a concrete hopper from which it passes through a two-roll crusher to a 25-ton per hour fixed-bucket hoist. The hoist is so

arranged that it dumps directly to a 120-ton steel bunker in front of and above the boilers. Provision is made for the installation of a flight conveyor when further extensions are made to the plant. The coal is fed through chutes to the stoker hoppers, a check on the weight of coal used being made by means of rod connections between stoker crankshaft and a standard engine revolution counter.

As the boilers have sufficient capacity at about 200 per cent of rating to supply the maximum steam demand and to respond to the sudden changes in load without appreciable drop in the steam pressure, no accumulators are used.

The exhaust steam and condensate from the hammers are returned to an open heater and makeup tank directly above. The makeup tank is provided with sufficient capacity to take care of the slugs of water discharged by the return pump on the heating system and returns from the hammers and to obviate unnecessary overflowing of the heater which would otherwise occur. Two feed pumps placed adjacent to the heater supply the feed water to the boilers under control of feedwater regulators and differential pressure governors. The heater is fitted with a V-notch indicating and recording meter.

The returns from the heating system in the plant and shop are handled by return pumps in the basement of the boiler room and discharged to the hotwell or makeup tank above the heater. City water is used for makeup, and this is treated with a zeolite softener before being fed to the boilers.

The designing and construction of the plant were carried out under the direction of Fred M. Hoadley, consulting engineer, Albany, N. Y.

Arc Welding as Applied to Power Machinery

By W. L. Warner*

MADE at the proper time, repairs may save costly damage to machinery and large losses due to the equipment being out of service. Electric arc welding can frequently save time and money in making repairs to power equipment. The armature shaft of a gen-

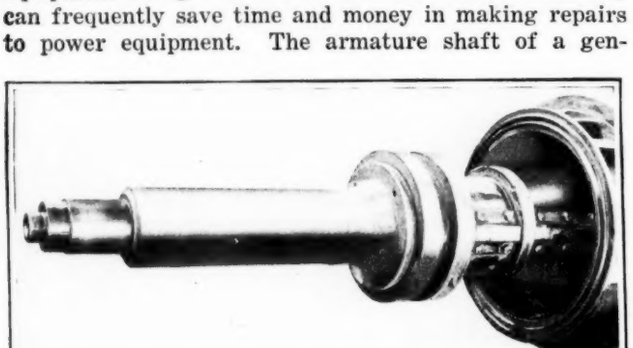

Fig. 1—Rotor shaft built up by welding and then machined to size

erator or motor wears—not excessively, it is true, but nevertheless, it wears; and after a time this wear must either be taken up, repaired or a new shaft inserted. The insertion of a new shaft is somewhat expensive, and usually the armature must be sent to an electrical repair shop for this purpose.

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Worn shafts can often be built up by arc welding and then machined to size without dismantling the armature. Fig. 1 shows one end of a rotor shaft which has been built up by automatic arc welding and remachined. This armature and shaft weigh 12,000 lb. and form part of a 2,500-kw. generator. By using arc

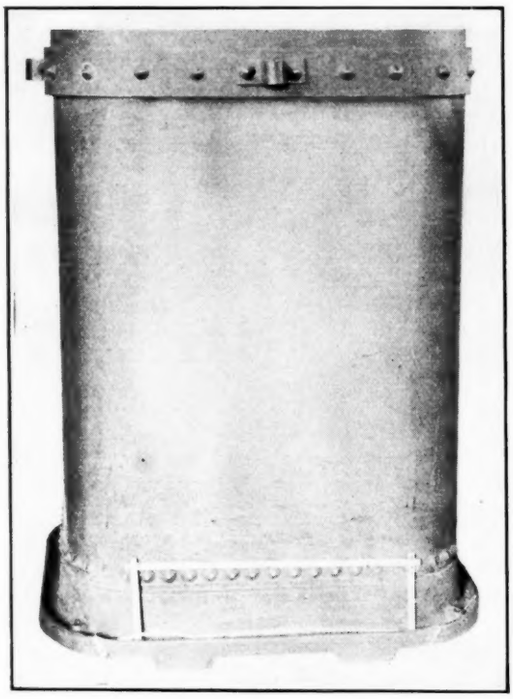

Fig. 2—Cracked base of transformer tank repaired by welding

welding in this way, the old shaft may be made to give a great deal more service at a fraction of the cost of a new shaft.

Sometimes the unexpected happens, and in such cases the arc welding process often proves of great value. In Fig. 2 is shown a transformer tank, the broken base of which is arc welded. The rule shows the length of the weld. Breaks of this nature in cast-steel and cast-iron parts of switches, circuit breakers and transformers may often be satisfactorily repaired by welding more economically than by any other method.

Outside of the value of the electric welding arc for general repair work around power plants, it may be advantageously used for new construction in the place of rivets. Under this heading comes the steel framework for supporting outdoor switching equipment and transmission lines. Protective railings and screening, steel flooring and stairways also offer opportunities to utilize, at a low cost, the electric arc welding method.

In addition to the things already mentioned as possible applications for electric-arc welding, there is also the building itself. The type of construction may be reinforced concrete, or steel and brick, or a combination of both types. In either case arc welding may sometimes be used for joining the steel parts, but the best opportunity occurs in the second type mentioned where the entire framework is built of structural steel. It may be stated, that as time passes, greater use of arc welding will be made, and eventually, the process will become standardized in a manner similar to the riveting process, which has required so many years to reach its present state of perfection.

Selecting Forced-Feed and Motor-Cylinder Oils for Navy Use

By J. G. O'NEILL
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The purchase on a scientific basis of lubricating oils for various departments of the government has led to a vast annual saving. The general properties of forced-feed and motor oils, their behavior and testing are briefly described.

IN ORDER to determine whether a lubricating oil has been properly refined, it is necessary to subject it to a large number of tests. Since crude oils from different sources have different properties, so also do the refined oils from these crudes have different properties.

To judge properly of the qualities of lubricating oils one must be familiar with the characteristics of crude and refined oils from various sources. When this information is available, all tests conducted on lubricating oils are of value, but lacking such information, not many of these are of much worth. In other words, capable testing of lubricating oils is comparable to the intelligent testing of any other engineering material; account must be taken of the limitations of the material and its suitability for the purpose intended.

General Testing Methods

For instance, consider the method of testing forced-feed oils for Navy use. The oil is first given a thorough chemical examination to show its freedom from any of the chemicals used in the refining process, its freedom from organic acids and corrosive compounds, the absence of tarry or asphaltic matters, the absence of constituents which would cause it to emulsify with steam and the absence of excessive quantities of unsaturated compounds, which would tend toward the formation of asphaltic matter or sludge by oxidation during use.

The physical properties show the source of the oil, whether or not it has the proper flash and fire points, its property of remaining liquid under different ranges of temperature, and its ability to maintain a lubricating film under various conditions of temperature and pressure. The non-emulsifying or demulsifying properties of the oil with distilled water, salt water, caustic solution and boiling distilled water are determined in order to find the resistance of the oil to the formation of emulsions with these solutions, should it become contaminated with any of them when used aboard ship.

An endurance test is also conducted, which is equivalent to practically 1,000 hours' service aboard ship; this gives the frictional properties of the oil, an exact knowledge of the changes which the oil undergoes in service, the tendency, if any, to gum or sludge, and information of the ability of the oil to maintain a lubricating film under the most severe conditions it could possibly meet in service. In addition to these the oil is given a practical test aboard ship in order to know positively that it is suitable in all respects for the intended purpose, and also to test the ability of the refiner to deliver large quantities of the same grade of oil.

Practically the same procedure is carried out in the testing of motor cylinder or aviation engine oils, with the exception that the practical test of aviation oil is conducted on a 400-hp. Liberty aviation engine, mounted on a test stand. The test is run for five hours with full throttle opening and all engineering data taken. The remaining used oil is given a complete examination after the run; from the condition of the used oil the performance of the engine and the specific consumption of gasoline and oil, the suitability of the oil is determined.

Choosing an Oil

The choice of a lubricating oil is dependent on a number of conditions, namely: The temperature of operation, bearing pressure, journal rubbing speed, clearances of bearings, skill of operator, condition of machinery, possibility of contamination or dilution of the oil in service, vibration of machinery and the ability to maintain oil pressure.

In forced-feed lubrication there is formed a film of oil between the bearing metal and the rotating shaft and the friction generated is between the molecules of the oil as they tend to slide over each other; very little friction is due to metallic contact of the shaft and the bearing metal. The viscous lubricating oils give a thicker lubricating film than the less viscous. They require more power to shear the oil film and consequently produce more friction and heat.

The proper viscosity should be that which is only slightly more than is necessary to prevent metallic contact so that the power consumed by friction is at a minimum. Since the viscosity of mineral oils varies with the temperature, the temperature of operation in forced-feed systems controlled by a cooling means should be sufficiently high so that the friction is low, yet that the oil has sufficient body to maintain a perfect lubricating film.

Heavy Oil for High Bearing Pressure

The viscous or heavy oils produce a thick lubricating film, and it is for this reason more difficult to squeeze the heavy oils from between bearing surfaces. Such oils are used where the bearing pressures are high, the clearances large or the temperature of operation high.

In a high-speed bearing it is necessary to use a thin oil because it gives the minimum of friction and because the friction generated by the high rubbing speed of the journal would be abnormally increased by the use of a heavy oil. In high-speed bearings the bearing pressure is generally light, which permits a thin oil.

Conditions which favor oils of slightly higher viscosity for marine practice than for shore practice are, the losses from leakage and splashing decreasing with the increasing viscosity of the oil used, the greater possibility of the presence of vibration which necessitate the presence of a thicker cushioning film and the great diversity of service that one grade of oil is called upon to give since it is objectionable to carry a supply of many different grades.

Poorly Installed Machinery Requires Heavier Oil

The care used in the manufacture of the machinery and in its installation plays an important part in the choice of the proper lubricating oil. It has been found that very carefully manufactured and installed machinery may be lubricated with a much thinner oil than would otherwise be possible. Invariably, inferiority of machinery, poorly installed machinery and machinery allowed to get in bad condition require the use of heavier grades of lubricating oils.

Forced-feed and motor-cylinder oils for Navy use are classified as follows:

Class	Viscosity, Saybolt Universal at 130 Deg. F	Used for Lubrication of
Light	100-115	Turbines (bearings only) turbo-generators up to 100 kw., dynamos and sight-feed gasoline engines.
Medium	125-145	Turbines, turbo-generators, 300 and 500 kw., reduction gears of small turbines, blowers and general machinery.
Heavy	180-200	Main engine turbines of battleships, and destroyers, reduction gears, reciprocating engines with forced-feed lubrication.
Extra heavy	240-260	Diesel engines of submarines.
Ultra heavy	300-320	High-power and high-speed gasoline engines with forced-feed lubrication.
	Viscosity at 210 Deg. F.	
Aviation, winter	75-85	Aviation engines operating in cold climates.
Aviation, summer	90-100	Aviation engines operating in warm climates.

Forced-feed oils in use increase in viscosity due to the evaporation of the lowest boiling constituents, which are the lowest in viscosity. This is because each of these oils is composed of a number of different oils of widely varying viscosities and boiling points. The presence of a large percentage of unsaturated compounds in the oil will also tend to increase the viscosity of the oil during use, owing to the fact that these compounds break up and oxidize, producing compounds of greater viscosity. Unsaturated compounds such as acetylene are so called because of characteristics of chemical formula indicating instability.

All lubricating oils in service darken in color, due to oxidation of the oils and the production of asphaltic resins or asphaltic matter. These dark-colored compounds are produced by the oxygen of the air or oxygen in the oil itself acting on the unsaturated compounds under conditions of heat and pressure. They are precipitated from the oil by the addition of 88-deg. Baumé gasoline.

Unstable or Unsaturated Compounds Cause Sludge

Recently, a mineral lubricating oil of viscosity of 85 sec. at 130 deg. F. was subjected to the 100-hour test in the endurance testing machine. It contained 38 per cent of unsaturated compounds. At the end of the test the oil was examined and found to contain 19 per cent asphaltic matter by volume insoluble in 88 deg. Baumé gasoline.

A well-refined mineral oil of the same viscosity, containing not over 8 per cent of unsaturated compounds and subjected to the same test, will not show more than a trace of matter insoluble in 88 deg. Baumé gasoline. The asphaltic matter produced in forced-feed oils during use does not tend to sludge out to as great an extent as that produced in motor cylinder oils.

Sludge produced in motor cylinder oils consists largely of free carbon either from decomposition of the lubricating oil, or partial combustion of the fuel and cracked products from the lubricating oil. The carbon is insoluble in the lubricating oil and settles out; also the oils are contaminated with gasoline, which exerts a precipitating action on the heavier asphaltic bodies in the oil and tends to throw them out as sludge.

Forced-feed oils show considerable acidity after long use because the asphaltic resins produced by oxidation are acid in nature. Motor cylinder oils are not subject to such a long period of use as forced-feed oils and do not show the presence in the used oil of as great acidity.

Well-refined forced-feed oils retain their non-emulsifying properties for a long period after being put into use, provided the lubricating oil system is clean and all bearings are well fed with oil. Motor cylinder oils, however, in service rapidly become emulsifying owing to the finely divided condition of the insoluble matter in the oil.

Animal or Vegetable Oils Should Not be Added

There is no advantage in the addition of animal oils, vegetable oils or fatty acids to forced-feed oils, and there are many disadvantages caused by the emulsifying or corrosive properties of these materials. Neither are there any good effects from their use in motor cylinder oils, with possibly the exception of oils of too heavy viscosity, when they may assist the spreading properties of the oil and render slightly better lubrication.

Graphite should not be used, since it greatly assists in the formation of sludge in both forced-feed and motor cylinder oils and does not reduce the frictional properties of the oils.

It is believed that with improvement in operation and design of motor cylinders the same methods of testing and choosing lubricating oils will apply to motor-cylinder oils as at present apply to forced-feed oils. In the future, a comparatively few grades of mineral oil may be used for lubricating purposes instead of the innumerable brands and grades in use at the present time.

In the Test Code of the American Society of Mechanical Engineers it is recommended that the tightness of the suction and discharge valves, and the plunger packing if the pump is of the inside-packed construction, should be ascertained by applying the specified discharge pressure on them and observing the leakage by removing a handhole or manhole cover on the suction side of the part being tested. The valves should be tight and the plunger packing should leak only enough to insure that the friction of the packing on the plunger is not excessive. In the case of direct-acting pumps with inside-packed plungers the amount of leakage may be estimated by closing the discharge valve and running the pump just fast enough to maintain the normal discharge pressure.

The Properties of Steam in Relation to Nozzle and Orifice Flow

By WILLIAM J. WALKER, Ph. D.
University College, Dundee, Scotland

IT HAS been common British practice to compute theoretical steam-turbine nozzle velocities and discharges from formulas based on the assumption of constant specific heat. In the author's opinion this incorrect assumption (expressed by the formula pv^n = constant) leads to serious inconsistencies. He presents modifications which take account of the varying specific heat and bring theory into better accord with recent experiments.

MANY anomalous and conflicting results have been obtained by different experimenters when measuring the discharge or velocity coefficients of steam nozzles and orifices. The variables affecting the theoretical discharges of nozzles are numerous, and neglect of the effect of one or several of these variables is the natural source toward which to look for explanation of the discrepancies. Each of the variables has in turn, been subjected to close experimental and theoretical scrutiny, but it has usually turned out that an explanation along certain lines involving perhaps accurate enough experiments on one or more of the variables, has been completely nullified by further observations on the effect of other variables.

Experimental Work in England and America to Shed New Light on Steam-Flow Problems

In the theory of nozzle flow the variables that may affect the theoretical discharge are:

A. Physical properties of steam.

B. The effect of pressure head, nozzle dimensions and ratio of pipe to nozzle diameter on (*a*) the coefficient of velocity, (*b*) the coefficient of contraction.

The work of Professor Callendar has done much to advance general knowledge of the properties of steam, and whether or not the tabulated physical data given by him represent the true values, there is no doubt that the thermodynamical basis of treatment that he has developed will provide the greater part of the foundation on which revised data must be built up from further experiment. In this connection the investigations at present under way[1] in the American Institutions under the auspices of the A. S. M. E. should prove of value to engineers all over the world.

The purpose of this article is to draw attention to a new line of development in theory which the writer is engaged in applying to experimental work at present in progress, but for the correctness of which strong circumstantial evidence has been provided by recently published[2] experimental results obtained by the Steam Nozzles Research Committee of the Institution of Mechanical Engineers (London).

In the theory of internal-combustion engines the neglect of the effect of variable specific heat has been well known for some years to be the primary cause of much of the observed difference between experimental and theoretical results, and various methods of analysis, more or less complicated, are in vogue, which are designed to allow for this factor. In the region of turbine-nozzle theory, however, with its dependence on both thermodynamical and hydrodynamical equations of flow, the effect of variable specific heat does not appear to have been considered seriously, an omission that appears worthy of attention.

The writer's formulas and method of analysis, developed in connection with internal-combustion engine theory appear to be accepted now as the most convenient and simple of application. It is sufficient to state here that the method consists in the development of strictly theoretical "correction factors" which are designed to be used in conjunction with the already existing formulas involving constant specific heat. The success of the method has led to its further development and application to the theory of steam or gas flow through nozzles and orifices, and the first verifications provided, indicating the accuracy of the analysis, are good.

Ordinary Assumption Regarding Gas Expansion Does Not Accord with Theory or Practice

In the theory of gas or vapor flow it has always been the general custom to assume that the expansion follows the law pv^n = constant. The writer does not agree with the making of this assumption. He holds that, just as in gas- and oil-engine theory, it is bound to obscure certain subtle variations that cannot be explained by any logical turnings and twistings of argument, which so many have sought to apply after basing their theoretical computations on the foregoing formula. Ascribing suitable values to n, in order to account for discrepancies, is merely a form of empirical dodging and has no firm basis either in theory or in experiment.

Formulas for Steam Flow

The formulas usually given for steam velocity and discharge, under the assumption of constant specific heat are, respectively,

$$U_c = \left[2g\,\frac{\gamma}{\gamma-1}\,p_1v_1\left(1-x^{\frac{\gamma-1}{\gamma}}\right)\right]^{\frac{1}{2}} \text{ feet per sec. } \ldots (1)$$

and

$$Q_c = A\left[2g\,\frac{\gamma}{\gamma-1}\,\frac{p_1}{v_1}\left(x^{\frac{2}{\gamma}}-x^{\frac{\gamma+1}{\gamma}}\right)\right]^{\frac{1}{2}} \text{ lb. per sec. } \ldots . (2)$$

where p_1 is the pressure in the reservoir in pounds per square foot, v_1 the specific volume of the steam in cubic feet per pound, x the ratio of discharge pressure to reservoir pressure and γ the ratio of the specific heat at constant pressure to that at constant volume.

Under variable specific-heat conditions the modified

[1] Articles in the Aug. 5, 12, 19 and 26, 1924, issues described work under way at Bureau of Standards, Mass. Inst. of Technology and Harvard. Also, an article in the July 28, 1925, issue describes Professor Callendar's recent investigations.—Editor.

[2] No. 3, Vol. 1, 1924, Proceedings of the Institution of Mechanical Engineers.

formulas, derived by the writer[3], corresponding to (1) and (2) are

$$U = U_c \left[1 + \frac{\lambda T_1}{4m}\left(1 - x^{\frac{r-1}{m}}\right)\right] \ldots\ldots\ldots\ldots (3)$$

and

$$Q = Q_c \left[1 - \frac{3\lambda T_1}{4m}\left(1 - x^{\frac{m-1}{m}}\right)\right] \ldots\ldots\ldots\ldots (4)$$

the expressions in square brackets being the "correction factors" to which reference has already been made.

In these formulas T_1 is the reservoir temperature, while $m = \frac{A}{B}$ and $\lambda = \frac{S}{B}$ are derived from $K_p = A + S\,T$ and $K_v = B + S\,T$ where K_p and K_v are the specific heats at constant pressure and constant volume respectively, A, B and S being constants and T the absolute temperature.

Equations (3) and (4) involve expressions that approximate more and more closely to the truth as λ becomes smaller. Since λ for all gases is relatively very small, the formulas may therefore be expected to yield practically correct indications of the qualities required. The outstanding feature of the formulas is the change of sign in the expressions for velocity and discharge correction, a result which, when obtained, occasioned considerable surprise in the writer's mind. Its substantial correctness, however, appears now to be assured by the verification provided.

In the second report of the Steam Nozzle Research Committee, page 375, the curves shown here in Fig. 1 are given. These represent a comparison between the committee's results and those of prior investigators, made by D. S. Anderson, the gist of Mr. Anderson's remarks consisting in the fact that while curve 8 representing the committee's results had an upward slope to the right, the other curve showed a downward tendency. The important point to note, however, is that the committee's curve was derived from velocity calculations, while those of all the other prior investigators were

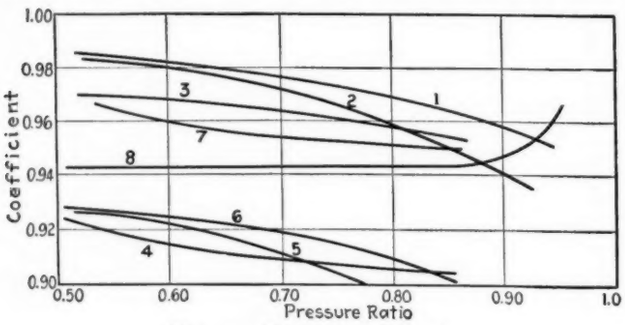

Fig. 1—Nozzle coefficients

Nos. 1 to 7 are coefficients of discharge obtained by various investigators, while No. 8 is a coefficient of velocity obtained by Steam Nozzles Research Committee.

derived from discharge values. Mr. Anderson, however, maintained that this fact should make no difference in the general trend of all the curves, and his difficulty was to reconcile this predominating difference. There is no doubt that this is the general opinion, but reference to formulas (3) and (4) shows that the opinion is wrong. Not only so, but, since λ is negative for steam within the experimental ranges concerned, the velocity coefficient curve 8 should, according to formula (3) slope upward as x the pressure-ratio increases, if, owing to uncertainty with regard to specific heat variations, the true effect of such variations has not been sufficiently taken into account. Also, according to formula (4), and assuming the same neglect of specific-heat variations, the discharge curves should slope downward as practically all observers have recorded, although unaware of the true explanation for such results.

The foregoing verification is good, but the question appears to be fairly well clinched by further data given

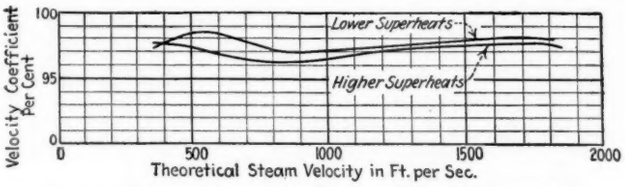

Fig. 2—Effect of superheat on velocity coefficient

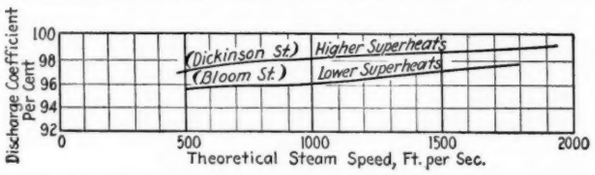

Fig. 3—Effect of superheat on discharge coefficient

in the third report. Figs. 2 and 3 are reproductions taken from pages 476 and 513 of that report and show the effect of superheat on the velocity and discharge coefficients. Both the velocity and discharge coefficients for these curves have been calculated from Callendar's equations and data and, as will be observed, the curves occupy reversed positions in relation to superheat. This, assuming again that the specific heat variation has not been sufficiently assessed, is what should happen according to equations (3) and (4). These indicate that, when λ is negative, the higher superheats will give the lower velocity and the higher discharge coefficients. The verification thus provided by these experimental results is carried to an even greater degree, for it can be seen from the curves that the effect of superheat is greater in the case of discharge coefficients than in the case of velocity coefficients. According to the writer's equations the difference, that is, the distance between the curves, due to superheat, should be three times as great in the case of the discharge coefficients as in the case of the velocity coefficients. Inspection of the curves in Figs. 2 and 3 indicate that this agreement is also approximately accorded by results.

Referring now to the summary of the variables that may affect the actual velocity and discharge values, it appears practically certain that with a given streamlined nozzle insuring practically constant coefficients of velocity and contraction throughout a range of tests, a condition that the writer considers to have been approximately realized in the tests under review, none of the factors involved, except the physical properties of the medium, can account for the discrepancies indicated. It is scarcely likely that the agreement of the results with the writer's formulas is accidentally due to variations introduced by friction, viscosity or stream contraction, since none of these factors could give the reversal effect indicated so clearly both by theory and experiment. Of the accuracy of the experiments there appears to be no possible doubt. The conclusion to be drawn, therefore, is that the specific-heat variations of steam are greater than is generally appreciated.

[3]"The Effect of Variable Specific Heat on the Discharge of Gases Through Nozzles," *The Philosophical Magazine* (London), March, 1922.

CHART FOR DETERMINING FLOW OF STEAM IN PIPES

Designed by N.T. Bourke

	AUTHORITY	FORMULA	REMARKS
D	D'Arcy (Kent's Adaptation)	$W=\sqrt{\frac{(P_1-P_2)d^5}{VL}} \times C$	Pipe Diam., In. 1, 1½, 2, 2½, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 16, 18 — Value of C 45.3, 50.0, 52.7, 55.0, 56.1, 57.8, 58.4, 59.5, 60.1, 60.7, 61.2, 61.8, 62.1, 62.3, 62.5, 62.7
K	Kurst – Martin	$W=\sqrt{\frac{(P_1-P_2)d^5}{VL}} \times 56.5$	
G	Geipel – Kilgour	$W=\sqrt{\frac{(P_1-P_2)d^5}{VL}} \times 50.2$	
B	Babcock	$W=\sqrt{\frac{(P_1-P_2)d^5}{VL(1+\frac{3.6}{d})}} \times 87$	
Not Plotted	Gutermuth	$W=\sqrt{\frac{(P_1-P_2)d^5}{VL}} \times 53$	Has a Value Intermediate Between K and G
Not Plotted	Hawksley	$W=\sqrt{\frac{(P_1-P_2)d^5}{VL}} \times 54.4$	" " " " " " " "
Not Plotted	Unwin – Carpenter	$W=\sqrt{\frac{(P_1-P_2)d^5}{VL(1+\frac{3}{d})}} \times 87.5$	" " " Practically Identical to B

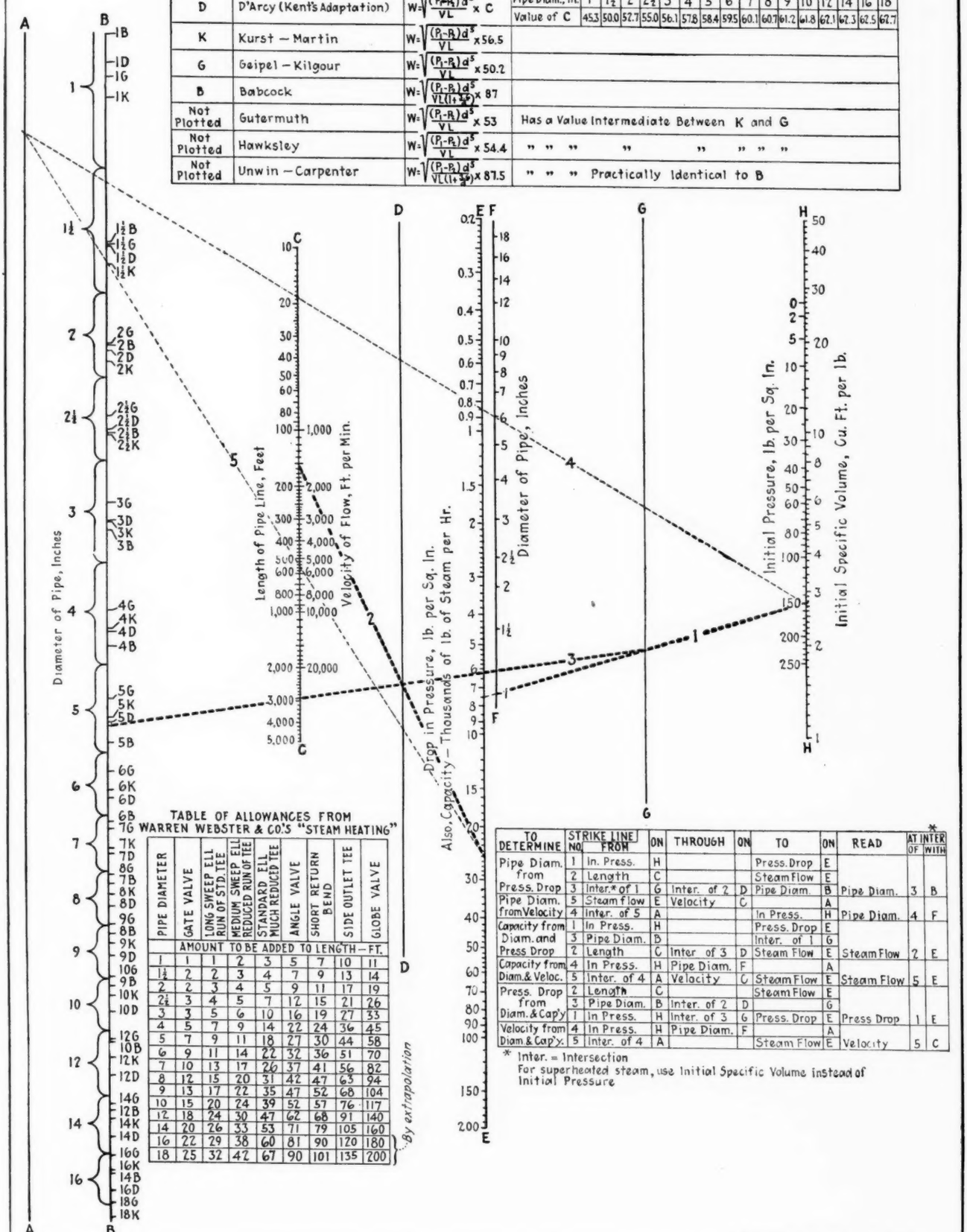

TABLE OF ALLOWANCES FROM WARREN WEBSTER & CO.'S "STEAM HEATING"

PIPE DIAMETER	GATE VALVE	LONG SWEEP ELL RUN OF STD. TEE	MEDIUM SWEEP ELL REDUCED RUN OF TEE	STANDARD ELL MUCH REDUCED TEE	ANGLE VALVE	SHORT RETURN BEND	SIDE OUTLET TEE	GLOBE VALVE
	AMOUNT TO BE ADDED TO LENGTH – FT.							
1	1	1	2	3	5	7	10	11
1½	2	2	3	4	7	9	13	14
2	2	3	4	5	9	11	17	19
2½	3	4	5	7	12	15	21	26
3	3	5	6	10	16	19	27	33
4	5	7	9	14	22	24	36	45
5	7	9	11	18	27	30	44	58
6	9	11	14	22	32	36	51	70
7	10	13	17	26	37	41	56	82
8	12	15	20	31	42	47	63	94
9	13	17	22	35	47	52	68	104
10	15	20	24	39	52	57	76	117
12	18	24	30	47	62	68	91	140
14	20	26	33	53	71	79	105	160
16	22	29	38	60	81	90	120	180
18	25	32	42	67	90	101	135	200

By extrapolation

TO DETERMINE	STRIKE LINE NO.	FROM	ON	THROUGH	ON	TO	ON	READ	* AT INTER OF	* INTER WITH
Pipe Diam. from Press. Drop	1	In. Press.	H			Press. Drop	E			
	2	Length	C			Steam Flow	E			
	3	Inter.* of 1	G	Inter. of 2	D	Pipe Diam.	B	Pipe Diam.	3	B
Pipe Diam. from Velocity	5	Steam flow	E	Velocity	C		A			
	4	Inter. of 5	A			In Press.	H	Pipe Diam.	4	F
Capacity from Diam. and Press Drop	1	In Press.	H			Press. Drop	E			
	3	Pipe Diam.	B			Inter. of 1	G			
	2	Length	C	Inter of 3	D	Steam Flow	E	Steam Flow	2	E
Capacity from Diam. & Veloc.	4	In Press.	H	Pipe Diam.	F		A			
	5	Inter. of 4	A	Velocity	C	Steam Flow	E	Steam Flow	5	E
Press. Drop from Diam. & Cap'y	2	Length	C			Steam Flow	E			
	3	Pipe Diam.	B	Inter. of 2	D		G			
	1	In Press.	H	Inter. of 3	G	Press. Drop	E	Press Drop	1	E
Velocity from Diam. & Cap'y.	4	In Press.	H	Pipe Diam.	F		A			
	5	Inter. of 4	A			Steam Flow	E	Velocity	5	C

* Inter. = Intersection

For superheated steam, use Initial Specific Volume instead of Initial Pressure

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Power-House Heating and Ventilation*

WHILE the ventilation of the turbine room has been carefully considered in several instances, there are many installations relying entirely on natural ventilation, by windows and roof ventilators, with results that are reported as adequate, apparently making any considerable expenditure to facilitate ventilation as of questionable value.

The tendency, in most of the larger stations, to operate the generator on a closed recirculation cooling system, eliminates the constant discharge of heated air into the turbine room, which in some of the older plants resulted in high room temperatures.

The excessively high room temperature and poor ventilation in the turbine-room basements of older installations have been avoided in modern plants by eliminating the floor at the main operating level and substituting galleries around the main units, resulting in unrestricted circulation of the air between turbine room and basement. The extensive substitution of motor-driven in place of steam-driven auxiliaries has also contributed to the lowering of the basement room temperature.

No uniform practice is apparent in the design of heating equipment for the turbine room, but the tendency seems to point toward the omission of all heating provision except a current of warmed air at the windows, provided to counteract the cold down current. This is accomplished by wall radiators directly below the windows, or by indirect heaters and ducts having slotted openings that cause a thin curtain of hot air to flow along the window surface. The heat dissipated by radiation losses from equipment and piping is sufficient, except in extreme cold weather, to result in a comfortable room temperature.

Roof condensation has been entirely eliminated in most modern plants by the installation of some form of roof slab incorporating an insulating material which will greatly retard the transmission of heat from the inside to the outside air. A layer of cork, hair felt or equivalent, laid on the roof slab and covered with the usual roof covering, has proved entirely satisfactory. The elimination of steam auxiliaries and piping and the elimination of the open discharge from the steam gland seal on the main units have greatly reduced the cause and, therefore, the liability of roof condensation, but the installation of roof insulation over the turbine and electrical rooms is becoming universal in order to allow for extreme and emergency conditions.

Boiler Room

No uniformity exists in the design of heating for the boiler room, as the particular arrangement of boiler room and basement, fans and ducts, and ash disposal makes each design a separate problem. Usually, however, some direct radiation is supplied at the windows on the main operating floor, and sufficient radiation is supplied in the basement to give a working temperature well above freezing in extreme cold weather.

The practice in the past of taking the air for the forced-draft fans from the ash tunnel and other portions of the boiler-room basement resulted at times in basement room temperature sufficiently low to expose the water piping to freezing. The tendency now is to provide a special entrance for the air for the forced-draft fans, isolated from the remainder of the basement.

Several modern plants obtain a part of the supply for the forced-draft fans by withdrawing the air from the boiler room, either from definite points, by means of ducts, or by natural circulation, through grating floors; and in some instances this has been supplemented by openings into the turbine room and arrangements made for supplying fresh air from outside of the turbine room. This latter arrangement apparently fills all requirements for turbine- and boiler-room ventilation, but requires ample indirect heating equipment for the fresh air entering the turbine room in order to avoid low turbine-room temperatures in extreme cold weather.

The general tendency appears to favor withdrawing the air from the turbine room from near the ceiling instead of from the basement. The two methods are probably equally effective in winter; but in summer, removing the air from near the ceiling would help to keep the room temperature down.

The large quantities of air required by the forced draft fans insure frequent change of air with slight additional expenditure of power.

*From a report just issued (July, 1925) by the Prime Movers' Committee of the N.E.L.A.

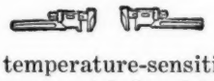
Boys, You Must Watch Those Gages!

The following appears in the editorial column of a recent issue of the *Chicago Tribune*. Those jets of steam are not safety-valves being blown, neighbor, but all the same they represent a lot of heat units that might, in many cases be usefully applied.

You can see a good deal from the twenty-fourth floor that you don't notice from below. You're looking down on practically every roof in Chicago. Chimneys, too. Too much smoke; but all that has been said before. Clouds of steam everywhere.

We don't suppose the steam discharged into the air causes much loss to anybody except the owner of the building which is wasting it. That escaped steam costs money to make. It need not have been wasted. There's no steam cloud over Mr. Wrigley's building or Mr. Insull's. We can't see our own, but we know there's no steam there, either. That's because we keep the right kind of boys down below.

Escaped steam is chiefly the fault of careless engineers and firemen. They don't watch their gages closely enough. The fireman at more or less regular intervals leaves his rocking chair and pipe long enough to toss some more coal on the fire whether it needs it or not. Then back to the chair and the pipe. Notice how often the steam cloud hovers over the roof half hidden by smoke.



Thermalloy is a temperature-sensitive magnetic material composed of copper, nickel and iron, the percentage of each depending upon the characteristics it is desirable to give to the alloy. At normal temperatures this material possesses magnetic qualities, but these qualities vary with changes of temperature. For example, at 68 deg. F. the permeability of the material may be 50, whereas at 212 deg. F. it becomes non-magnetic. The magnetic qualities are also affected by the composition of the alloy. With 30 per cent copper it may become non-magnetic at 212 deg. F., but if it contains 40 per cent copper it may become non-magnetic at a temperature of 68 deg. F. One of the uses of this material is for compensating watt-hour meters for changes in temperature.

Still With Power After Forty Years

FORTY years ago the head of the McGraw-Hill Company, James H. McGraw, entered the employ of the American Railway Publishing Company, which had but a few months before founded *Power*. He had previously been a school principal and was a recent normal school graduate. Within a few months he had taken a financial interest in the company and became its vice-president. When the publishing company dissolved, the firm of Swetland & McGraw took over *Power*. The senior partner, H. M. Swetland, had also been a school teacher and Mr. McGraw had been one of his pupils. The firm held the paper but a short time. In 1889 Mr. McGraw sold his interest to Mr. Swetland, who published *Power* for more than twelve years, until its purchase by John A. Hill in 1902.

It is interesting that the Fortieth Anniversary of Mr. McGraw's first connection with *Power* finds him at the head of the publishing house that now controls it.

Governing Steam Turbines at High Pressures

AN OBJECTION to higher steam pressures is the greater erosive effect of denser steam. Wear of this kind is likely to be more severe on a governing valve where throttling may be required for the purpose of regulating the load.

There are, however, ways of minimizing governing-valve erosion should this prove objectionable. Since higher-pressure units are usually for base-load service, it is possible ordinarily to hold a nearly constant load of such amount that little or no throttling is required. The load giving the greatest economy is the logical choice since it practically always requires full admission steam pressure and hence no throttling.

The method employed at Weymouth is to vary the steam pressure at the boiler in accordance with the load to be carried. This makes necessary an individual steam-generating equipment for the unit. Means of controlling steam temperature so as to get the benefit of a normal temperature and hence low internal loss at light load are desirable.

A valve element that gives satisfaction with ordinary steam may be unsuited to more rigorous conditions with regard to both material and design. It is to be expected that the avoidance of sharp corners and abrupt changes in direction of flow would be beneficial. Also the parts directly concerned with the throttling action may be separated from the elements that seal the valve tight when closed. Wear due to throttling would then be rendered less objectionable than if a steam-tight joint were required at this point when closed.

If the load conditions make necessary operation at light loads for a considerable part of the time, the high-pressure turbine nevertheless has a point in its favor. Water-rate curves for throttling turbines tend to become flatter for higher-pressure machines. Thus if a turbine at one hundred and fifty pounds were to be throttled to half load, a certain increase in percentage of normal water rate would occur. If, however, an equivalent unit at four times this rated pressure were throttled to half load, the water rate would be increased somewhere around half the aforementioned percentage. From this viewpoint some loads may be more efficiently handled by high-pressure units than by those of lower pressure. The practice of utilizing the lower-pressure and less economical plants to absorb load fluctuations has proved its value in practice, but where the choice lies between high- and low-pressure units at well below rated capacities, the higher pressure of the two may in some instances prove the more desirable for carrying load.

The Surge of Fuel

THE phenomenon of surges, which is of so much interest to the designers of hydraulic plants and electrical transmission lines, may also be observed in the economic field, particularly in the field of fuel supply and demand.

Speaking broadly and roughly, three fuels are available for power boilers: Bituminous coal (all grades), anthracite (fine sizes only) and fuel oil. Bituminous coal is, and will doubtless continue to be, the great staple. The general adoption of low-temperature carbonization in the future would not contradict this statement, since bituminous coal would be the main source of supply for the carbonization process. Fuel oil and steam sizes of anthracite are in the picture and will stay there for some time, although they can never attain the position of bituminous coal.

Picture a situation momentarily stable, in which the majority of power plants are using bituminous coal and a smaller number using anthracite and fuel oil. Assume that into this situation a new element is injected. Fostered by Henry Ford and other energetic Detroit citizens, the purchase of automobiles increases by leaps and bounds, until it appears that practically every family owns one. With the enormous increase in automobiles goes a corresponding increase in petroleum production to supply the gasoline needed for their operation. Using the most efficient known methods for the recovery of gasoline from crude oil, there is still a considerable percentage of all the oil produced which must be marketed as a boiler fuel. As a result, the price of fuel oil begins to go down.

Everybody wants to burn oil. The moment the price begins to fall, oil-burning installations start going in here and there, first in localities where oil has the greatest advantage over coal and later in localities where the advantage is less. Soon there is a general wave of enthusiasm for oil burning; everybody wants

it, even those who are not properly situated for its economical use. Coincident with this great increase in the demand for boiler oil may come marked advances in the technique of oil "cracking," increasing the percentage yield of gasoline and at the same time reducing the amount of fuel oil available. The result is a sudden rise in the price of fuel oil, freezing out the users, who reluctantly go back to coal one after another.

Meanwhile, likely as not, the steam sizes of anthracite coal, which have lost many customers to fuel oil, have become a drug on the market. The disappointed users of oil, looking around for something cheaper, are attracted by the low-priced supply of "smokeless" anthracite. About this time reports of an impending strike give them a bad case of "cold feet" and they fail to install the anthracite-burning equipment. So things swing first one way and then another. All the time our sooty old friend, *bituminous*, available in practically unlimited quantities, continues to carry the brunt of the power load.

Better Than Going to Waste

MUSCLE SHOALS power development today is one of the most prolific subjects of discussion in this country. No matter what the government or others interested in this project may do, it is immediately criticized. It could hardly be expected that the sale of the power from this plant during the testing period would be an exception, even though there were no other sources through which the government could dispose of the power. Test loads could be obtained by placing electrodes in the forebay, but it would seem that most any price for this power would be better than using it to heat the Tennessee River.

Two mills per kilowatt-hour is over thirteen dollars per horsepower-year and would be a low rate for dependable power at this time. However, blocks of dependable power that did not require maintaining a steam plant ready to take over the load at any time, have been sold at a rate about twenty-five per cent less than what the government is receiving for Muscle Shoals power. According to the published terms of the agreement under which this power is sold, the purchaser is not assured of the amount to be supplied or when it will be supplied, which would mean that an equal amount of steam reserve capacity must always be in readiness. Under such conditions the power is worth only about the cost of the coal saved at the reserve steam plants, less the cost of the coal to keep these plants ready for service, which with low-priced coal is probably not far from two mills per kilowatt-hour.

Keeping Down Construction Costs

WHILE the operating and maintenance costs of power stations have remained fairly constant, the fixed charges in most cases have more than doubled during the last ten years. This has been accompanied by marked improvement in efficiency, which must be balanced against the increased fixed charges. Unless the saving due to the improvement in efficiency can be made to pay the increased charges, the higher efficiency cannot be justified on economical grounds.

A great deal of attention has been given to obtaining high efficiency and reliability, but this is only half the problem. There are other factors of cost and operation that must be considered. The fact that the operating and maintenance costs have remained practically constant, with rising costs of labor and material, with increased complication in power equipment and the more severe conditions under which modern apparatus must operate, would indicate that operation and maintenance have been given careful study. But as these costs combined represent only about one-quarter the value of the fixed charges per unit output, the latter require even more careful consideration.

Of the fixed charges about the only one that the designer can control is the capital charge. Not only is this influenced by the design of the plant, but it may also be controlled to a considerable extent in the construction of the project. The latter probably has not been given the attention that it should. There is a vast difference between a well-planned construction program and just starting in to build the plant according to the idea of those in charge of construction. In a very large water-power project recently completed in record time under adverse circumstances, more time was given to the design and layout of the construction work than to the design of the power house. If this had not been done, the great amount of work accomplished on this undertaking could not have been done in the time that it was.

Working to a well thought out plan not only reduces the cost of construction, but also shortens the time required to get the plant into service. The latter reduces the interest account that must be charged into the original investment and consequently helps to keep down the capital charges in the project.

Engineers as Salesmen

IT IS one of the vagaries of our industrial and economical system that the man who comes around selling apparatus and supplies to the engineer is usually better paid, more highly regarded, gets more joy out of life and occupies a higher social standing than his customer.

This has always been so. It is only recently that the engineer has been paying the mason and pipefitter that he calls in to do odd jobs more than he gets himself.

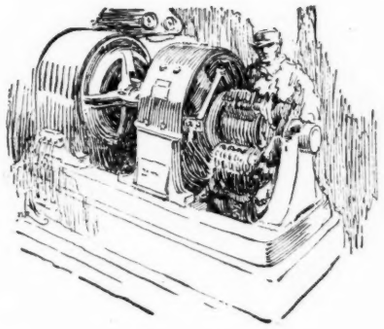
At a recent meeting of manufacturers of and dealers in industrial apparatus the procuring of efficient salesmen was one of the questions considered. The opinion was general that the ideal salesman would be one who had used the apparatus himself as an operating engineer, who knew its possibilities and its limitations, who knew the language of the engine room and the line of thought that would most often and most speedily inspire an interest in and desire to buy the product.

And it was unanimously regretted that more of the bright, intelligent men who possess these qualifications do not venture upon the outside life, with its wider opportunities for fellowship and expansion and its promise of larger success.

Another evidence of the interest that manufacturers are now taking in the importance and the economies to be effected in the proper operation of the industrial power plant, is seen in the announcement that the Furniture Manufacturers' School, now being held at the North Carolina State College, will have as a part of its course the problems of machinery and equipment and power-plant operation.

The *Power* Index for the first six months of 1925 is now available and will be mailed free to subscribers upon request.

Practical Ideas from Practical Men



WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. The winners for June will be announced this month.

Peculiar Points in Power-Plant Design

Quite frequently, the operating man encounters peculiar points in the design of the plant he is operating, which lead him to wonder whether the designing engineer expected the apparatus to endure forever without replacements or repairs.

I remember a case where a horizontal closed heater was placed in an almost inaccessible position below a mezzanine floor, and then later a large high-pressure steam line was run directly in front of the removable head.

Although the heater was made with a removable tube bundle to facilitate inspection and renewal of tubes, this arrangement of the steam line (which was not a necessity) precluded the possibility of removing the tube bundle from the shell, and practically made it impossible to remove a single tube without taking the heater out of the line bodily. Yet the designer casually suggested that the tube bundle be removed at frequent intervals for external inspection of the tubes to detect corrosion.

When his attention was called to the matter of inaccessibility, he was quite complacent about it and remarked that there would in all probability be few renewals to make.

Another case was that of a turbine bleeder heater which was placed in a restricted location, but with ample room on one end for the removal of the tube bundle. Owing to a mistake in laying out the piping the heater was placed wrong end to. With the heater in this position it would necessitate the cutting of a hole in the brick wall of the building, taking down a 24-in. atmospheric line on the other side of the wall and cutting out some structural steel, to permit the removal of the tube bundle.

In a certain industrial plant a closed heater was erected without either exhaust steam or water bypass connections. As the plant was equipped with noncondensing turbines, all the exhaust passed through the heater and in the event of a tube failing in the heater, a total shutdown would result. This would cause about 500 men to be idle while the damage was being repaired.

A modern plant was built at another place to replace an obsolete station. It was intended to be the last word in economy, all the auxiliaries to be motor driven, with bleeder-type turbines, for regulating the heat balance. Yet it was seriously proposed by the designer that there should be no steam stand-by auxiliaries, or emergency house turbine and no interconnection with another station, which meant that no auxiliary power would be available until one of the main units was up to speed and generating. It took the most strenuous efforts on the part of the man in charge of operations, to prevent this program being carried out.

The idea seemed to be that when once the plant was started by means of power from the other plant, which was to be dismantled, it would keep on functioning automatically. Electrical storms, which would in all probability disrupt the auxiliary system at the same time as the main system, were apparently not to be considered.

Many other cases of the designer failing to take into consideration the fact that all machinery is subject to disorder and needs repairs from time to time, could be cited, covering a wide variety of steam power plants.

The solution would seem to be, a little actual plant experience on the part of the plant designer, accompanied by a liberal amount of common sense.

Memphis, Tenn. HENRY CLAY.

Phase Test Lamps for Three-Phase Circuits

A trouble experienced with three-phase alternating-current systems is single-phase operation; that is, one of the lines may be open at some point, generally at a

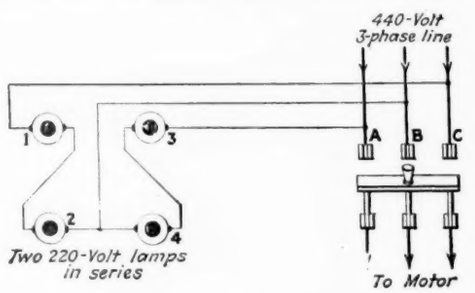


Diagram of test-lamp connections

set of fuses, or a break may occur in the line. Three-phase induction motors will not start single phase, but will continue to run if brought up to speed three-phase and then one of the wires disconnected. The result of a three-phase induction motor running single phase is that the windings may overheat and destroy the insulation if the motor is operating near full load.

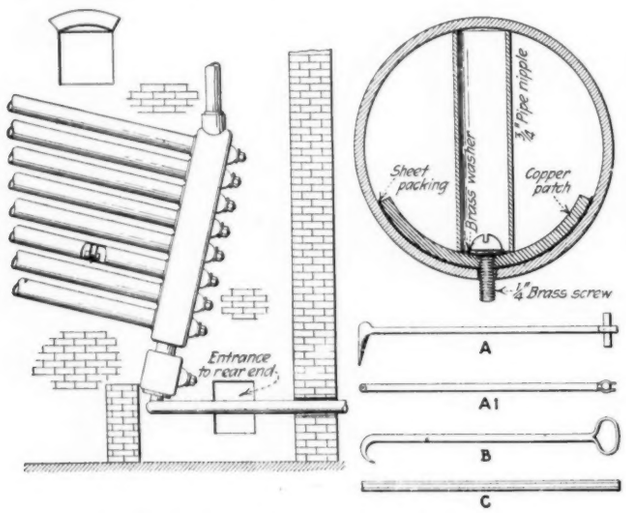
In order to avoid attempting to start the motors in a mine single-phase and also to give a visual sign that all three phases of the circuit are complete, I am using a set of lamps arranged as shown in the diagram at each motor installation, also at each main or branch line switch or fuses.

A glance at the lamps will indicate the condition of the current. If phase *A* is open, lamps 3 and 4 will not burn. If phase *B* is open, lamps 1, 2, 3 and 4 will light at reduced candlepower. If phase *C* is open, lamps 1 and 2 will be dark. If all three phases are O.K., all four lamps will burn at full candlepower. The test lamps were used mainly to check up on the circuit before starting the motors. With regard to the energy consumed by the lamps, in my case this was not taken into consideration, as we used the test lamps for lighting purposes, as most all the motors are underground in the mines. FRANK HUSKINSON.

Phoenix, Ariz.

How Small Leaks in the Boiler Tubes Were Stopped Temporarily

In a steam power plant where I was formerly employed, we had considerable trouble at one time from pitting in the tubes near the rear of boiler and small leaks would frequently appear in the tubes. As we



Method of making repair and tools used

were in need of all the boiler capacity we had, we used the method shown in the illustration of stopping the leaks temporarily.

When a leak was discovered, the boiler was cut out of service, the blow-down valve was partly opened, and at the same time water was pumped into the boiler equal to the amount being blown out. This was continued until all the pressure was off the boiler. The blow-down valve was then opened wide and the boiler emptied. At the same time the damper was opened and air circulated through the boiler to cool off the setting.

The man making the repairs would enter the center, pass of the boiler and locate the leaking tube while water was issuing from it. As soon as the water reached a point below the leak, the cap of the tube was removed. The leak was then located with the pointed tool *A* and the tube cleaned around the hole, a half-round file with a handle attached, being used to scrape the surface of the tube clean.

The patch was made of $\frac{3}{16}$-in. sheet copper, not less than 3 in. square for the smallest leak and larger if the metal appeared thin surrounding the leak. Frequently, two screws were used for one patch, one screw being cut off flush with the bottom of the patch, when the hole in the tube was not convenient for the location of both screws. The brass screw was screwed through the patch and the whole made watertight by packing, as shown in the illustration. The patch was set in place by using the forked end of the tool *A1* (*A* and *A1* being views of the same tool). The $\frac{1}{4}$-in. brass screw dropping into the hole showed when the patch was in place. The $\frac{3}{4}$-in. pipe nipple was then put in the forked end of the tool *A1* and placed over the head of the screw, being finally driven in place by using the bar *C*. As soon as the patch was in place, the tube cap was replaced, the boiler filled with water and put back in service. This repair required from two to three hours for a 5,000-sq.ft. boiler.

In addition to serving as a locating pin, the screw held the sheet packing in place while the patch was being located in the tube, and the head of the screw served to hold the lower end of the nipple while the top end was driven into place. The nipple was rounded slightlty at each end to facilitate installation.

The tools *A*, *B* and *C* could not be made more than 3 ft. long owing to the limited space between the headers and the rear wall. The pointed end of tool *A* was made a little longer than the diameter of the tube, for the purpose of enlarging a hole in the event of its not being large enough to take the $\frac{1}{4}$-in. screw. The hooked rod *B* was used for removing the stoppers when the tubes were renewed. By stopping the leaks temporarily by this method, a great deal of time was saved over that required to renew a tube. And by using the tools shown, all the work was done without putting the hands inside the tubes or header.

During the three months that the plant was required for emergency purposes, about fifty tubes were repaired in this way and the repairs were satisfactory. All tubes were renewed during the first slack period.

Vancouver, B. C. F. E. BESCOBY.

Taking the Curve Out of the Belt

When operating belt drives on which the pulleys are at right angles to each other, one is sometimes at a loss to account for the troubles that develop. Usually a quarter-turn belt will operate for a time, apparently, as efficiently as a straight one. Then it will start working gradually over to one side of either of the pulleys and the joint will begin to open a little at one side.

One of the best ways of arriving at the cause of the trouble is to take the belt off the pulleys, open the joint and stretch the belt out on the floor. Invariably, it will be found that it has been changed from a straight to a curved form because there has been more tension on one side than the other. A simple way of correcting this is to give the belt a half twist before replacing. This will make it run true on the pulleys and soon bring it back to a straight line J. E. NOBLE.

Toronto, Ont., Canada.

Comments from Readers

Diagrams from Low-Pressure Cylinder with Condensing and Non-Condensing Operation

In the June 2 issue Charles R. King gives an explanation of the low-pressure diagram shown in Fig. 2 in the article by William Hampshire in the Feb. 17 issue, and makes a somewhat lengthy comparison between

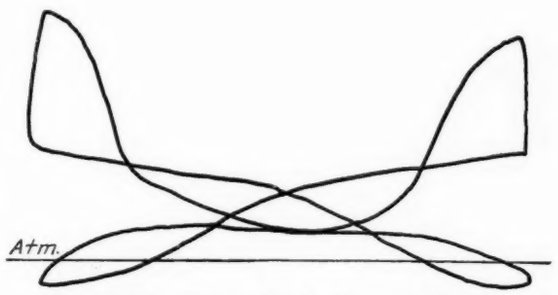


Fig. 1—Mr. Hampshire's diagram showing negative work

that diagram and two diagrams from a simple locomotive taken when "coasting" or running with a closed throttle.

It is rather difficult to find any basis for comparison in the two cases, as in the former case the steam valves are in direct communication with a supply of steam under pressure and the engine is therefore doing some positive work, while in the latter case the steam valves are only connected with a dead space, namely, the volume of the steam chest and the dry pipes, and this simply adds that much more volume to the cylinder clearance during the intervals that the steam valves are open.

It is obvious that any steam engine, when made to rotate while its throttle valve is closed, becomes an inefficient air compressor with mechanically operated valves, and that the total area of any diagram taken from it when so operating and exhausting to atmosphere, must show negative work. On the other hand, the entire area of such a diagram would represent positive work if the machine was considered as an air compressor. Under these conditions the length of cutoff could have but slight effect on the area of such a diagram provided the point of exhaust closure remained the same, for the amount of work done is almost entirely dependent on the amount of volume of air trapped in the cylinder by the exhaust valve.

An examination of the diagrams as represented by Figs. 2 and 3 in the article referred to and reproduced herewith, will show that the exhaust closure in Fig. 2, where the high compression was obtained, was much earlier in the stroke than in Fig. 3, where the compression was much less. In other words, there was a much larger volume of air in the cylinder at exhaust closure in Fig. 2 than in Fig. 3, and as both of these volumes had to be finally compressed into the same volume, namely, the clearance of the cylinder, the larger volume, as represented by Fig. 2, had to be compressed to the higher pressure and this irrespective of the point of cutoff. Neither could the speed have any appreciable effect on the area of the diagram, as the only possible effect would be the friction of the air entering and leaving the cylinder through the exhaust ports, and in any well-designed engine running at reasonable speeds this would be slight.

Referring to the diagram furnished by Mr. Hampshire (Fig. 1) Mr. King says that, "owing to the sudden failing of the vacuum the compression begins as soon as the piston starts on its return stroke." This theory must be based on the assumption that the diagram was taken at the moment the vacuum failed and before the engine had a chance to exhaust to atmosphere, but even in that event, which is not probable, the exhaust valve would have had to be closed. It is not reasonable to suppose that the piston could have compressed the steam remaining in the cylinder, exhaust chest, piping and condenser as rapidly as the diagram shows it must have done in the first few inches of its

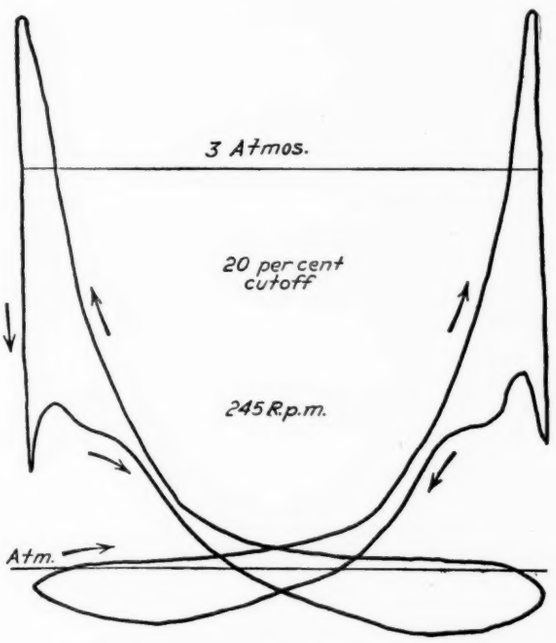


Fig. 2—Diagram from locomotive with throttle closed

travel. It is proper to assume, then, that the engine was exhausting to atmosphere and that this early and sudden rise of pressure in the exhaust line was caused by an inrush of air at release, tending to equalize the pressure within the cylinder with that of the atmosphere, and that compression did not begin until the exhaust valve closed.

Mr. Hampshire says in his article that the valve

setting was not changed on the low-pressure cylinder after the vacuum was lost. If he means by this that the valve setting proper was not changed but the point of cutoff was lengthened, and in so doing the point of exhaust closure was advanced to such an extent as to cause the excessive compression, then Mr. King's reading of the diagram is probably correct, although the reasons he assigns for obtaining such a diagram are at fault. Taking his reading as correct, the point of cutoff is at nearly 50 per cent of the stroke instead of 12 per cent as mentioned by him, and the point of exhaust closure, instead of being at about 85 per cent of the stroke, as shown by the diagram taken when

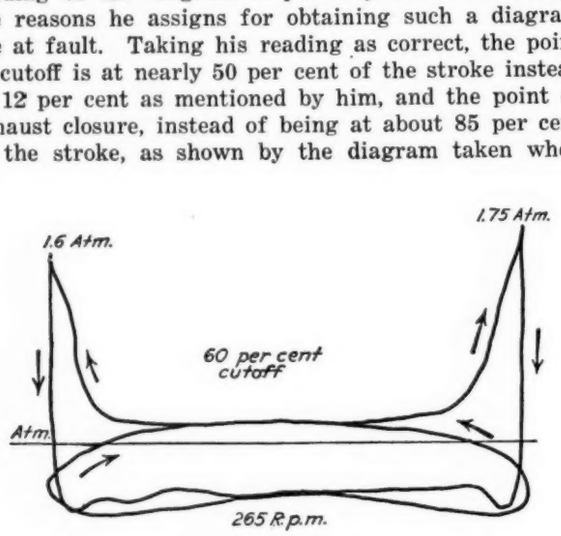


Fig. 3—Influence of lengthening cutoff

the engine was running condensing, has been advanced to about 60 per cent of the stroke. No explanation has been made regarding the shape of the latter part of the compression curve; however, nothing has been said as to the type of valve gear on the engine. If the gear is of the slide-valve type, such a compression line might be obtained by the valve lifting off its seat under the higher pressures.

J. D. CARR.

Los Angeles, Calif.

Utilizing Waste Firebrick

I have read the several discussions that have appeared in *Power* recently on the use of old crushed firebrick for boiler-wall maintenance and construction.

Having made an extensive study of the use of cured or recalcined brick and the benefits derived through the use thereof, I should like to make a few comments.

This study has taken me into boiler plants in every state in the Union, as well as in many foreign lands, and as a result of this experience, where a test and study have been made in a practical way, I feel qualified to say that in all the discussions I have read so far I cannot help feeling that the most important factor or point has been overlooked.

The point that makes it a crime to throw old firebrick away, regardless of salvage cost for any unit whether small or large, and the point that I have in mind, is the fact that where firebrick are purchased, the buyer always tries to get the best available for the purpose for which they are to be used.

These brick are then put into the walls of the furnace and the fire started. The furnace temperatures immediately start a further curing or calcining of the brick in the wall, and this process, naturally extending over a greater time than the original time of calcining the brick in the kiln, makes a better piece of refractory out of it and then when used over again it shows less shrinkage and in most every case will on the re-use stand more temperature.

You have then in this case actually made a better piece of refractory for your work than you were able to purchase at any price, for you now have a refractory nearly neutral, as far as shrinkage is concerned, to your operating temperature, with a higher fusing point. It is a well-known fact that where crushed firebrick is used in furnace wall work, the walls do not have the same temperature loss by conductivity, owing to the fact that minute voids are formed by the small particles coming in contact with one another, which in a small way take the characteristics of the diatom in insulation. These conditions make the use of old firebrick almost a necessity, whether the plant be small or large, where super-refractories or superpractices are required in order not to have excessive maintenance cost.

W. H. GAYLORD, JR., Vice-president,
Quigley Furnace Specialties Co., Inc.
New York City.

How the Water Hammer in the Exhaust Header Was Eliminated

The article by W. H. Collins, "How the Water Hammer in the Exhaust Header Was Eliminated" in the July 7 issue causes me to venture a possible reason why the water would not flow through the 4-in. pipe to the condensate tank.

I am supposing that the water was permitted to accumulate in the header before the 4-in. valve was opened. With the vacuum in the header, the opening of the valve caused just a part of the air in the tank to pass the water at the greatest trap, "the valve." As soon as the pressure in the tank decreased, the weight of the water would not allow any more air to pass the trap in the horizontal section of the pipe where the valve trapped the water enough to permit the pressure in the tank—sealed by the water and the trap in the line—and the vacuum to hold the water suspended in the line.

The present system can easily be made automatic with the addition of an electric plug contact switch in the shell of the tank, causing a motor and plunger pump to remove the water from the tank as it fills up from the header.

L. C. FOGG.

Portland, Ore.

Replying to the problem of draining a vacuum header by W. H. Collins, let me say that the 1-in. connection between drum and header in his illustration functions entirely as a vent. It serves precisely the same purpose under vacuum conditions as does the small vent beside it under atmospheric conditions. Under even the best possible operating vacuum the drum is as full of air as if it were under pressure, only that the air is more rarefied, owing to the reduction in pressure, which in this case we call a vacuum.

This air must be vented to allow it to move out as the water comes in.

Had the 4-in. valve been in one of the vertical sections of pipe, the air and water might have passed each other and the arrangement functioned slowly, but being in the horizontal run, it formed a perfect trap or seal and prevented that possibility.

Vancouver, B. C. R. MANLY ORR.

College Entrance Requirements for Engineering Students

Our engineering schools are beginning to admit that all is not well with their methods of selecting raw material and are tentatively trying out several new ones in hopes of finding better. As a first step they have tabulated some of the most easily observed and superficial surface characteristics of those students whom they now admit; they have ages, color, nativity, parental occupation, financial status, per cent of failure, etc., down in black and white. I suppose, also, that they know their average high-school grades and, maybe, their rank in their high-school classes. The latter, by the way, seems to many instructors a much more significant thing than the grades. We once had a student come to us who had an average high-school grade of 92 per cent who, as we found out on inquiry after he had failed in an engineering course, ranked number thirteen in a graduating class of thirteen students.

Now this work already done may be and probably is of some value, but it has little or no worth as a basis for admitting or keeping students out of engineering classes.

At present we have two main systems of admission, both highly irrational. One is based on the democratic ideal and a naïve belief that all students are mentally equal. It causes the admittance into the engineering courses of our state universities of all students who have graduated from high school with sixteen more or less specified points selected on a traditional basis. The other method, held to by the non-state-controlled schools, requires the prospective student to pass a traditional ancestor-worshipping examination which, judging from results, does not weed out half of those students who are lacking in one or more of the qualities necessary for the finishing of an engineering course in our colleges as they are now organized. Both these methods presuppose that preparation is necessary in some type of secondary school before a student can do engineering work. Also they specify over half of this required preparation rather closely.

Now, it is by no means certain that the colleges either require or test the things that they want, and if that is the case, their procedure, to characterize it mildly, is unscientific. We do know that some 62.5 per cent of the students who get over the hurdles fall by the wayside. We do not know how many who could have done creditable work are kept out by them. It is highly probable, however, that quite a few are.

If the colleges are ever to select their students on a rational basis, they must go about preparing their tests in a scientific manner. They must be based on observed behavior.

We must find out what abilities, characteristics and attitudes of successful engineers have contributed to their success and what ones have caused or helped cause failures in those who have taken up commercial engineering work and failed in it. Then we must find methods and devices for testing entering students to find out if their characteristics are likely to contribute to their success in engineering, or to find out if they possess the ability to develop the required characteristics and attitudes while in college. We might, while we are at it, quit demanding preparation in special subjects in high school and in otherwise trying to shift our burdens to them. In doing the work of finding these attributes, it would be wise not to set our standards of success too high nor those of failure too low nor to make them mainly monetary.

The customary questionnaire method would be worse than useless as a means of obtaining the data needed for solving this problem. To write to a hundred or a thousand engineers and ask their opinions would be to get the opinions of a certain percentage of them and nothing more.

It is a peculiar thing that a man who is careful and cautious in working out an applied engineering problem, who studies the question carefully, reads up on it and perhaps even tries it out on a small scale before recommending the expenditure of a large sum, will when asked concerning engineering education, produce a plan for saving the schools with a cocksureness inversely proportional to his knowledge of the problem.

Then a large percentage of the replies to questionnaires are given by those who have an ax to grind.

When such a questionnaire is sent out and the results are averaged, the results can not be set out as the truth of the matter. "The ignorance of a thousand people is no better than that of one; truth cannot be manufactured from constant errors by getting a great number of them."[1]

The statement by an engineer that he wishes that he had been required to take more mathematics at college does not prove that engineers need more nor that he needed more.

As a start toward rationalizing our procedure, we should next year provide every high-school senior or other prospective engineering student who desires it, with a pamphlet setting forth some of the things that most engineers have to do as engineers, how much work will be required of them in college, the average tenure of office and the wages that they can expect after leaving college. All this should be put out on a comparative basis also. Then they should be advised that an intelligence quotient of at least 120 is required to be able to do the required work with a fair degree of success, and a simple self-administering test should be inclosed together with a method of scoring and they should be advised to take it before coming to college and, if there is any doubt, to take a psychological examination before enrolling.

As an experiment we should allow prospective students who are not high-school graduates and who yet desire to enter, to do so if they are over eighteen and have an intelligence quotient of approximately 130 and have enough preparation to do rapid accurate work in arithmetic up to and through simple percentage and can read, write, speak and understand simple every-day English; questions in grammar and usage barred.

The actual records from a few hundred such students from several colleges would furnish much information as to the value from the viewpoint of entrance requirements of the high-school preparatory work.

The fact that suitable students are selected, does not mean that few or no students will fail. Our engineering courses may be and probably are ill adapted to turn out engineers, and too many of our instructors have a very unethical educational philosophy.

However, once a student has been admitted to an engineering course, his failure should be a matter of grave concern to his instructors, for it reflects discredit on their ability as teachers or on their ethical standards.

DeLand, Fla. DAVID E. DAVIS.

[1] Thorndike, Educational Psychology, Vol. I., p. 32.

Questions and Answers

Conducted by

Franklin Van Winkle

Governor with Single Reach Rod

When setting valves of a Corliss engine with single reach rod from the governor, which steam valve should have its cutoff set first? R. B.

Where there is a single reach rod from the governor, it usually is connected to the cam of the crank-end steam valve and the cam of the head end is controlled by a rod connected back to the cam of the crank-end valve. When thus connected, the crank-end cam receives first motion from the governor and therefore should have the cutoff set first by adjustment of the governor reach rod, after which the cutoff of the head-end valve should be set by adjusting the rod to that valve.

Reversing Engine with Shaft Governor

What is necessary to be done for reversing the running direction of an engine with shaft governor? L. G.

For reversing direction of rotation the eccentric must lead the new direction of the crank and the outward motion of the weights must move the eccentric toward the center of the shaft with the spring connections so arranged as to oppose outward motion of the weights. If the slot in the eccentric is not long enough to admit of as much motion to one side of the center as the other, a new eccentric sheave would be required and there must be appropriate centers for the governor connection for moving the eccentric in the opposite direction. With most engines reversal will require a new eccentric sheave or new governor pulley or a new keyway in the shaft.

Determining Alignment of Engine Guides

How can a test be made to determine whether the bored guides of an engine are parallel with the cylinder center line without detaching or removing the crosshead? W. L. D.

First locate a line through the center line of the cylinder. This should be considered to be a straight line which passes through the centers of the cylinder counterbores. Remove the cylinder head, piston and piston rod. Wedge a cross-rod of wood horizontally across the counterbore at each end of the cylinder with the upper surface of each rod at the center of the counterbore and locate the centers on the rods by lateral measurements. Place the crosshead at the crank end of its stroke and stretch a strong fine line from the crosshead through the cylinder, with one end fastened at the crosshead and the other end secured to a stationary object several feet beyond the end of the cylinder. Then adjust the ends of the line to agree with the cylinder center marks previously located with the line just clear of the cross-rods. Next firmly locate a true straight-edge, of wood or steel, over the top of the cylinder. Have the straight-edge extend over the full length and clear of the guides and head end of the cylinder and so adjusted, with the true edge down, so that it will be parallel with the cylinder center line according to measurements made from the center line near each end of the cylinder. Also locate a line along one side of the cylinder and the full length of the guides, parallel with the cylinder center line and at the same height, taking measurements near the ends of the cylinder center line. Then with a large pair of dividers or a tram made from stout wire determine for each of the guides whether both ends are the same distance from the straight edge and side line, when measured from the same part of the guide surface. For most practical purposes the parallelism of the lower guide can be tested by determining whether a point on the crosshead is at the same distance from the straight-edge and the side line at each end of the stroke; and the upper guide can be tested by determining the same measurements from the upper crosshead shoe when it is firmly set against the upper guide with the crosshead first at one end and then at the other end of its stroke.

Capacity of Wooden Tank

What would be the capacity of a wooden tank 29 ft. inside diameter at the bottom, 27 ft. diameter at the top, and 21 ft. deep? M. D.

The capacity can be determined by any of the several methods of computing the volume of the frustum of a cone which has an upper base 27 ft. in diameter, lower base 29 ft. in diameter, and a height of 21 ft. One of the simplest is the "prismoidal formula," namely:

Volume $= \frac{1}{6}$ *perpendicular depth* $\times$ *(area at top* $+$ *area at bottom* $+ 4 \times$ *area of section at mid-depth)*

One-sixth of the depth $= \frac{1}{6}$ of 21 ft. $= 3.5$ ft.

Area at top $= 27 \times 27 \times 0.7854 = 572.56$ sq.ft.

Area at bottom $= 29 \times 29 \times 0.7854 = 660.52$ sq.ft.

The diameter of section at mid-depth would be $(27 + 29) \div 2 = 28$ ft., and four times the area would be $4(28 \times 28 \times 0.7854) = 4 \times 615.75 = 2{,}463$ sq.ft.

Hence the volume would be $3.5 \times (572.56 + 660.52 + 2463) = 12{,}936.3$ cu.ft., or $12{,}936.3 \times 7.8 = 96{,}763.5$ gal.

Pitch of Steam Main

How should steam piping be pitched for drainage, toward the engine or for draining back to the boiler; and how steep should the piping be to prevent water from being carried over to the engine? J. A. G.

Piping should be pitched to drain condensate in the direction that the steam is to flow, that is, from the boiler toward the engine, except for the short distance from the boiler stop valve to the boiler, which should be pitched to drain back to the boiler, so that there will be no condensate held in the connection up to the

valve when it is closed. If the main piping is pitched to drain back to the boiler, the condensate will be carried to the engine from time to time as slugs of water are first gathered and held along the pipe, and then suddenly swept along by the steam. The water thus delivered temporarily faster than it can be taken care of at the engine, may result in a "smash." The pitch back to the boiler may be steep enough to obtain flow of the condensate in the direction opposite to the flow of steam, provided the pipe is so large that there is a very low velocity of the steam. But there always is danger of water being swept along with the steam at intervals even when the piping is vertical. A common example of this action is to be seen in irregular gushes of water from a vertical exhaust pipe, although the foot of the pipe may be provided with a good-sized bleeder.

Rusting of Steel Stack

We are troubled with "sweating" and rusting of a 42-in. diameter steel stack used in connection with an oil-burning boiler. How can this be reduced or prevented? *F. J.*

The condensate undoubtedly is derived from discharge of steam to the ashpit or furnace combined with condensation of steam derived from water contained in the fuel at times when the gases are not hot enough to prevent condensation of the water vapor on the sides of the stack. This would be more likely to occur when the fires are banked, or may be worse when the fires are started before the stack becomes heated. There should be no serious trouble from condensate arising from water contained in fuel or from steam that may be necessary for operation of oil burners, provided the stack is put together with the upper course of each joint entering the lower course, and the joints are filled with a good stack paint to prevent rain water from washing through to the inside. If the upper courses lap over the lower courses, the condensate will run through the joints, with concentration of the corrosion in streaks that will result in shorter life of the stack than if the condensate is distributed over the interior surface.

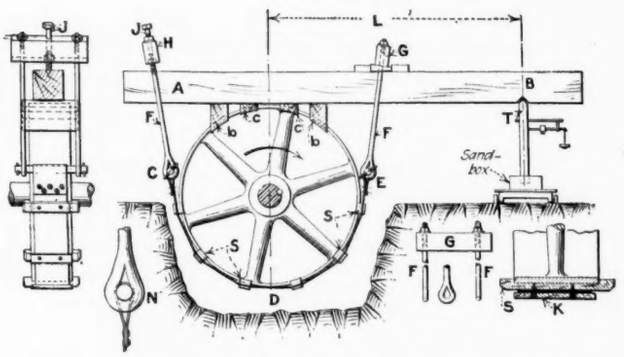
Brake for Testing Waterwheel

We wish to test the power of a horizontal-shaft waterwheel. How can a brake be made for taking up the power on a 72-in. × 14-in. face driving pulley that is on the mainshaft? The face of the pulley clears a rock-bottom wheelpit by only about 5 inches. *F. D.*

Having rotation of the pulley in the direction indicated by the arrow the situation would require application of some form of strap brake, such as illustrated. For a brake beam *AB* use a stiff 8x10 or 10x10-in. timber 14 to 16 ft. long, provided with notched blocks *b* and *c* beveled to fit over the face of the pulley.

A strap *CDE* may be constructed of a piece of 10- to 14-in. belting with each end turned over and riveted to form a loop for receiving a pin made of 2- or 2½-in. shafting, as shown at *N*, drawing up the strap at each end by a pair of eyebolts *FF* at the sides of the beam and passed through bolsters *G* and *H*. The bolster *G* may have a firm bearing on the beam, and for tightening the strap the bolster *H* may be provided with a bolt *J* passing through a nut sunk in the lower side of *H*, with the end of the bolt bearing on the beam. The brake strap should be provided with hardwood shoes *SS* notched out to receive the face of the pulley and secured to the strap at intervals by battens and wood screws as shown in detail at *K*. Cut a shallow notch in the bottom of the brake beam for receiving the upright support *T*, which may be held in place by a belt lacing tacked to the beam, and place a box of sand on the scales to receive the lower end of the upright. Care should be taken to have a good fit of the blocks *b* and *c* and shoes *S* to the pulley face. A bucket full of water should be at hand ready to quench fire.

While running off a test, the brake can be lubricated by having balls of lubricating grease thrown from a safe distance against any exposed portion of the face of the wheel while the strap is gradually tightened. Note the scale readings at frequent intervals while the wheel is running, and for computations use only those readings obtained when the wheel is up to full



Strap brake for testing power of horizontal-shaft waterwheel

speed, with marked head of water and wheel gates open a known amount, and when there is no chattering of the brake. When chattering begins, the tightening screw *J* should be slackened and the wheel shut down as soon as possible, and before making another trial the brake wheel should be allowed to cool sufficiently to obtain test figures with a smooth run.

Find the tare weight by slackening off the eyebolts equally to obtain clearance between the strap shoes and the pulley when the beam is supported on a three-cornered piece of wood or iron resting on the wheel as a "knife-edge" to support that section of the brake beam which, when the brake is used, is directly over the center of the shaft and take the length of brake arm as the horizontal distance *L* used in the tests.

The formula for computing the power developed is

$$\text{Hp.} = \frac{L \times 2\pi \times (P - t) \times N}{33{,}000}$$

where

L = Length of arm L in feet;
$2\pi = 3.1416 \times 2 = 6.2832$;
P = Greatest pressure on the scales, in pounds without chattering when the wheel is up to speed;
t = Tare weight when the brake and beam are supported on the "knife-edge" with the same length of arm L as when the noted gross test pressure is obtained;
N = Number of revolutions of wheel per minute.

[Correspondents sending us inquiries, should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

A new slant on things observed in and out of the power plant

What Happens and Why?

A Few Facts About Safety Valves

AS THE boiler pressure rises above normal, a faint sound of leaking steam may become audible. With a further rise in pressure of a pound or two this becomes a hiss. The safety

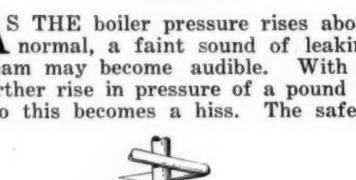


Fig. 1—Simple valve will have no appreciable "pop"

valve is getting ready to pop and is giving its "warning," yet it will not pop unless the pressure rises appreciably higher. With that rise in pressure is a slight increase in the intensity of the hissing sound and then a sudden, almost explosive pop, followed by the roar of escaping steam in large quantities. The pressure immediately starts to fall, but, strange to say, the valve does not close at the pressure at which it opened, but falls several pounds below that pressure before it finally closes tight.

When one stops to think about it for the first time, it seems rather strange that the safety valve should pop open suddenly. Why should it not start leaking at the set pressure, and then gradually increase its discharge with increasing pressure? Why, for example, should a certain valve merely "simmer" at a pressure of 150 lb. and at a pres-

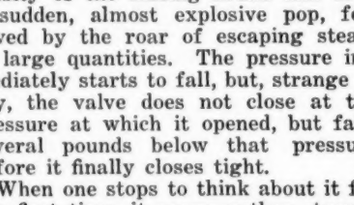


Fig. 2—Crude pop valve at moment when leakage is too small to start pop

sure of 151 lb. be wide open, with no intermediate stopping point?

This does not occur by accident, but by special design of the valve itself. Obviously, a simmering valve would be undesirable. It would make a pottering task of removing the excess steam from the boiler in case of overpressure, whereas the pop valve takes away an excess and makes a job of it, closing at the earliest possible moment. Again, a valve without a pop would be simmering and wiredrawing much of the time, with resulting wear and destruction of the seat.

The general idea involved in the design of a valve that will pop sharply when a certain pressure is reached, is simple enough, and it is only in the detailed design of these valves for definite and reliable performance under difficult conditions that the real engineering skill is involved.

Taking up first a simple spring-loaded disk, as shown in Fig. 1, it is evident that this valve would have no appreciable pop. It is shown just simmering at 150-lb. pressure. With increasing pressure the distance of the valve from the seat would gradually increase, but would never become very great. Suppose a few attachments were added to this valve as shown in Fig. 2. These consist of a second larger disk fastened above the first and sliding loosely in a shallow cylinder or ring.

Now let the steam pressure be brought up to 150 lb. as shown at Fig.

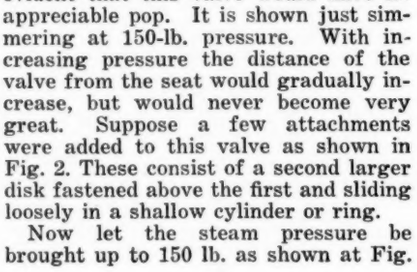


Fig. 3—Pressure suddenly applied to enlarged area produces pop

2. The valve will again simmer slightly due to the small amount of steam leaking past the seat. This leakage will be so small that it will escape easily through the clearance between the upper disk and the ring. But suppose the steam pressure increases to 151 lb. as shown in Fig. 3. The leakage increases to a point where an appreciable pressure builds up in the "huddling chamber" below the edge of the disk. This extra force will carry the disk up a little farther, which in turn will result in more steam passing into the huddling chamber and a still further lifting effect. It is apparent that the effect is cumulative, after this point is passed, so that the disk shoots suddenly up to the position shown in Fig. 3.

The *popping pressure* of this valve is practically independent of the construction of the huddling chamber and of the upper disk, depending only upon the diameter of the lower disk and the compression of the spring. The height of the pop depends on many factors, such as the diameter of the upper disk, the height of the "huddling chamber," the clearance between the disk and the ring, the type and compression of the spring, etc.

It will be noticed from Fig. 3 that, in addition to the static push of the steam on the enlarged area, there is the impulse of the rapidly moving steam striking the outer edge of the disk. Practically all of the pop safety valves on the market make use of both of these effects as well as a third effect obtained by bending the upper edge of

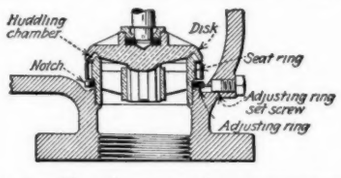


Fig. 4—Showing popping arrangement of a commercial valve

the valve disk downward to increase the lifting effect of the steam jet.

The disks and seats of two typical valves are shown in Figs. 4 and 5. It will be seen in Fig. 4 that after the valve pops, part of the steam escapes from under the edge of the enlarged valve disk and part of it passes down through holes in the seat ring to a leakage space above an adjustable ring. Adjustment of this ring regulates the escape of steam at this point and thus determines the lift. In the arrangement shown in Fig. 5 the amount of lift is adjusted by what is known as a relief-adjusting ring. Raising this ring increases the lift.

A high lift goes hand in hand with a large blowdown. A valve set to pop at 150 lb. might require blowing down to 145 lb. before it would seat again. It is important that the regular operating pressure of the boiler be below the blow-down pressure, otherwise the

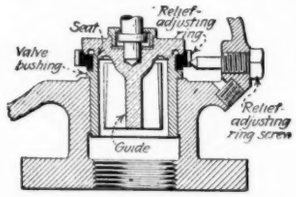


Fig. 5—Portion of another commercial valve

valve will not seat after it pops unless the pressure is artificially reduced.

Without going into details it may be said that in general the popping pressure of safety valves is controlled by adjustment of the spring, while the amount of pop and the amount of blowdown is controlled by adjusting special rings, disks, screws, etc., which regulate the escape of steam from the disks after the pop begins.

Suggested Rules for the Care of Power Boilers*

Proposed as an addition to the A. S. M. E. Boiler Construction Code

IT IS the request of the Committee that these proposed rules be fully and freely discussed so that it may be possible for any one to suggest changes before the rules are brought to final form and presented to the Council for approval. Discussions should be mailed to C. W. Obert, Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be considered by the Committee.

V—Partial Rules for Installation

Boilers

C-295. All boilers, with their auxiliaries and appurtenances shall be located, as far as practical, where they will be least liable to damage from external forces such as building failures, flywheel explosions, flood, fire, or explosions from the storage of inflammable material, belt-transmission failure, and other possible disasters.

C-296. Where pipes pass through the brickwork of settings, they shall pass through suitably packed openings or through sleeves of ample size to permit expansion and contraction of the pipe.

C-297. Foundations for steam boilers must be of ample size to carry the load, and where large concentrated loads fall within a small area of the foundations, as in the vertical types of boilers, the foundations should be reinforced and spread to prevent any settling which might throw the boiler out of line.

C-298. Foundations and structures supporting a steam boiler shall be built to withstand any strain which may be transmitted to them by expansion or contraction of boiler or supports, and shall be tied together in such a manner as to maintain their proper relation.

C-299. Vertical fire-tube or water-tube boilers whose bases cover a small area shall be carefully shimmed to distribute the load equally at all points. All shims shall be of steel or iron and properly secured or grouted.

C-300. On settings of the suspended type care shall be taken to see that the load is properly distributed over all points of suspension.

C-301. With suspended settings the steel supports shall be designed and be of sufficient strength and rigidity to eliminate any strain on the brickwork by excessive expansion and contraction of the steel supports.

Steam Pressure Gages

C-302. Steam gages shall be placed where they will be free from objectionable vibration and where they can be conveniently adjusted. They shall be so placed that they will not be subjected to a temperature of less than 40 deg. F. or more than 150 deg. F. They shall be so placed that the operator will have a clear and unobstructed view when standing within the usual operating area in front of that side of the boiler on which the gage is installed.

C-303. All boiler steam gages shall be of such size and so proportioned and marked that the graduations and the position of the pointer can be clearly determined by a person with normal vision standing at a distance equal to one and one-half times the width of the boiler front and at an altitude equal to the distance of the gage above the operating floor.

C-304. The minor graduations of a steam gage having a maximum range of 300 lb. shall indicate a pressure not greater than 10 per cent of the working pressure and in no case a pressure greater than 10 lb.

C-305. All steam gages should be so graduated that the pointer will be in a nearly vertical position when indicating the normal working pressure, and all boiler steam gages in one boiler room should be similar in graduation of face.

C-306. When it is necessary to place steam gages high above the operating floor, they may be tilted forward at a sufficient angle (not to exceed 30 deg. with the vertical) to permit a proper view of the dial graduations.

C-307. At all times, the steam gages shall be well illuminated and free from glare or reflection so that they can be read with ease from the normal position of the operator. No light shall fall directly into the eyes of the operator when observing the gage.

C-308. There should be provided in the boiler house an independent and reliable auxiliary source of illumination. Where other more satisfactory systems are not expedient, tubular lanterns should be kept in readiness at all times.

Water Glasses

C-309. Water glasses shall be so constructed, placed, and illuminated that the level of the water in the glass can be readily determined from the most desirable position. Types of water glasses and guards which prevent the free determination of the water level shall not be used.

Safety Valves

C-310. When the allowable working pressure of a boiler has been reduced, when a boiler is equipped with increased stoker capacity, or when a change in fuel permits increased combustion, the capacity of the safety valve shall be recalculated, using the requirements given in Pars. P-260 to P-290 (inclusive) of the Power Boiler Section of the Code. If the rules for capacity require a greater valve capacity, it shall be installed.

C-311. Test the valves in accordance with the instructions given for the particular plant. Test the safety valves by gently raising the valve off the seat by hand or, when practicable, test the valves daily by raising the steam pressure to the popping pressure of the safety valve. Small chains or wires attached to the levers of pop safety valves and extended over pulleys to other parts of the boiler room may be used. If the valve sticks, do not try to release it by hammering; drop the pressure in the boiler and clean the valve seat or correct any other defect that may be found. When an additional safety valve is installed on a boiler in excess of the capacity required by the Rules for the Construction of Power Boilers and the capacity of that valve is equal to the capacity of the faulty safety valve, the boiler may remain in operation until it can be conveniently taken out of service.

C-312. To prevent injury to operators, boiler, and setting, if necessary a safety-valve escape pipe shall be installed to carry the discharge or any condensation away. Escape pipes should be supported so as to prevent any strain upon the safety valve.

C-313. The discharge from the open end of the escape pipe shall not be obstructed. If the sound of the discharge of the safety valve cannot be heard by the operator, a suitable alarm for warning the operator shall be installed.

C-314. The drip from the drain in the escape pipe shall be carried clear of the boiler setting. Where a drip pipe is installed, the inlet end shall be equipped with an open funnel providing a clear view of the drip and it shall be so installed that the drip will be protected from freezing.

Intercommunicating Valves between Systems of Different Pressures

C-315. Where intercommunicating systems of different steam pressures are installed with boilers on each system, the boilers on the low-pressure systems shall be equipped with non-return check valves. All low-pressure headers and their outlets shall be protected by a relief valve or valves whose combined capacity shall be equivalent to the total amount of steam that can pass from the higher-pressure system into the lower-pressure system, unless a suitable approved automatic shut-off device be applied on the high-pressure side which closes automatically from excess pressure on the low-pressure side. In determining the total amount of steam that can pass from one system into another system, the calculations

*The rules were presented at a public hearing at the A.S.M.E. Spring Meeting in Milwaukee. On account of the length of the rules *Power* is printing them in short installments, of which this is the eighth.

shall be based upon the popping pressures of the safety valves in the two systems. Where a reducing valve is used, a hand valve shall be installed also. A steam gage shall be installed at a convenient point for the guidance of a person when operating the hand valve in lieu of the reducing valve.

C-316. Whenever the total amount of steam that can pass from a higher-pressure system into a lower-pressure system has been increased, the relief-valve capacity shall be increased an equivalent amount in accordance with Par. C-315.

Feedwater Supply

C-317. If two systems of piping to the boilers are used, it is recommended that the two systems enter the boiler at different points.

C-318. When electrically driven feed pumps are used and there is no other independent source of electrical supply, there shall be maintained ready for service, steam-driven feed pumps or injectors of sufficient capacity to safeguard the boilers in case of failure of electric power.

C-319. Where the level of the water in the feedwater tanks, which are directly connected to the suction line of the feedwater pumps, cannot be observed easily by the water tender or pump operator, suitable water glasses or water-level indicators shall be installed.

C-320. For locating deposits or other obstructions in a feed pipe, it is recommended that a pressure gage be placed on the discharge chamber of the boiler-feed pumps or on the discharge pipe outside of the feed pump and another pressure gage be placed in the feed line near the boiler.

C-321. Where feedwater regulators are used and there is no additional feedwater line to the boiler, they shall be by-passed or so constructed that they may be readily held open.

C-322. Where other than independently fired economizers are used there shall be a water by-pass around the economizer.

C-323. Where there is a possibility of oil in returns to open feedwater heaters, they should be provided with oil filters. Entrainment from return lines should be passed through a suitable filter or extractor; exhaust mains should be dripped and the oil separated out. Where extraction which is contaminated with oil is mixed with extraction which is not so contaminated, oil separators shall be placed on the extraction lines containing oil before mixing with the clean extraction, so that the separation may be more efficient.

Dampers

C-324. All dampers shall be so installed that they can be conveniently operated.

C-325. Where automatic control devices are used on inlet and outlet dampers they should be installed in such manner that any failure of or accident to their mechanism will not allow the inlet damper to open or the outlet damper to close.

C-326. A draft gage and a temperature-indicating device connected close to the outlet damper are of value in indicating operating conditions.

Fuel Supply

C-327. Where fuel-supply regulators are used to control liquid, gaseous, or pulverized fuels, they shall be so installed that any failure of or accident to the mechanism of the regulator will not increase the supply of fuel.

Blow-Off Line and Valves

C-328. Blow-off pipes shall be so located that all exposed portions within the building and within any pipe tunnel opening directly into the boiler room can be inspected, and all portions within the valved area shall be installed to withstand full working pressure of the boiler.

C-329. Blow-off valves and cocks shall be in such location that they are accessible, and if located in a trench or tunnel, an extension shall be applied to the valve stems so that they may be operated from the floor or some convenient and safe location.

C-330. When practicable, the blow-off line should be so installed as to provide a visible means of detecting leakage.

C-331. Blow-off pipes shall be supported and anchored to prevent strain being thrown on to the boiler structure on account of expansion or contraction.

Support of Structures

C-332. Structures supporting a boiler, or that part of the building structure in close proximity to the boiler, shall be protected from the heat of the boiler by insulating materials or ventilated air space. Steel members should not be heated to a temperature of more than 600 deg. F. Concrete should not be heated to a temperature of more than 400 deg. F.

C-333. Steel structures supporting boilers shall be carefully protected from water from roofs or steam leaks, and inflammable material shall not be stored close to supporting structures.

C-334. Where supporting columns between settings, or near boilers, are exposed to corrosion, they shall be set on concrete piers at least one foot above the floor level, or shall be encased in concrete at least 2 in. thick, to a point above which corrosion will not occur. Supporting columns not protected by concrete against corrosion shall be exposed so that they can be thoroughly inspected, and shall be kept well painted.

Pipe-Line Supports

C-335. Pipe lines connected to boilers shall be installed with provision for expansion and contraction. Pipe lines shall be braced to prevent strains on boiler or connecting pipe lines, and supports shall be of sufficient strength and designed to withstand strains set up by possible water hammer or vibration.

C-336. Pipe-line supports should not be attached to temporary structures which might be removed, or to wooden structures which might be injured by fire. Supports for piping shall not be attached to wooden or steel structures such as floor or roof beams, which might be affected by changes in load.

Stack Supports

C-337. When stacks are supported from structures directly above the boilers, or from the boilers themselves, care shall be taken to protect all steelwork from corrosion caused by water at this location running down on the stack, or from the roof.

Belting and Shafting Supports

C-338. Shafting and belting shall not be located over the boiler in such a position as to cause injury to the pipe lines, or cause strains on the boiler if an accident should occur to the belt or the line of shafting. Supports for shafting shall be of sufficient rigidity, or, if necessary, separate structures should be provided for supporting the shafting in such way to prevent vibration being carried to pipe lines, or to the boiler.

Tenant's Right to Install Power

By A. L. H. Street

Where a power plant is a usual adjunct of a given line of business, a lease of a building to be used by the tenant in conducting such business implies permission on the part of the landlord to install and operate such a plant, holds the Washington Supreme Court in the case of Jurek vs. Walton, 236 Pacific Reporter, 805.

Plaintiffs leased to defendants a storeroom in Tacoma, to be used as a meat market. Defendants installed a refrigerating plant operated by a 5-hp. motor. Other tenants in the building complained of the vibrations caused by the plant, and plaintiffs sought, but unsuccessfully, to enjoin defendants from continuing operation of the plant. It was held by the court that a clause in the lease, forbidding any act on the part of the tenants which should be dangerous or injurious to the building, did not prevent reasonable operation of a suitable plant. The opinion says:

"A lease of premises for a particular use constitutes a license to carry on the stipulated business by the ordinary methods and with the usual appliances. So in this instance, since the use of a refrigerating plant is the ordinary and usual adjunct of a meat market, right to use it is an implied covenant of the lease. Nor can the somewhat general words of the restrictive clause contained in the lease forbid its use. The clause would forbid, no doubt, the installation of a plant the operation of which would prove dangerous or injurious to the building, but . . . nothing of this sort follows as a result of the operation of the plant in question. It was the ordinary plant, larger than some, but smaller than others in common use, and made no more noise and caused no more vibration than the usual plant of its kind. It may be that, owing to the manner in which the building of the appellants was constructed, the operation of the plant caused more annoyance to other tenants of the building than was contemplated when the lease was entered into, but this was not the fault of the lessees, and if a loss to the lessors arises therefrom, they alone must bear it."

Damage Done to Power Equipment by the Earthquake in Japan

AFTER the earthquake in Japan, Sept. 1, 1923, it was proposed that a joint committee be organized by the Institute of Electrical Engineers of Japan, the Japanese Electro-Technical Committee, and the Electrical Association of Japan, in order to conduct an investigation of the earthquake effects and fire, and to make recommendations to be adopted as precautionary measures for future time. The committee was organized in November of the same year, under the name of the Earthquake Investigation Committee for Electrical Installations. It consisted of about sixty members, all being engineers selected from the electrical utility concerns and government officials within the affected area. All available information was collected from different sources, and over forty meetings were held. In September, 1924, a report of the committee was finally drawn up and was published in Japanese in December of the same year. The president, M. Shibusawa, of the Japanese Electro-Technical Committee, made an abstract of this report, giving a general outline of its scope, and translated it into English as a reference for other countries where earthquakes are likely to occur. This abstract was presented in the form of a paper before the International Conference of Large Transmission Systems, in Paris, during June of this year. The following is an abstract of the paper:

Causes of Damage in Steam Plants

Practically all damages sustained by the machinery in steam- and gas-power stations were the results of the sinking of foundations, the collapse of buildings, or the falling of chimneys, etc. The principal reason for the severity of damages caused to these stations is that they are necessarily located near the seashore or river banks to obtain good facilities for fuel handling and water supply, but where the soil formation is generally unsuitable for the installation of heavy machinery.

Boilers, as a rule, suffered no serious damage from the earthquake, although in some cases such minor effects as the falling of furnace arches or sidewalls resulted. In other cases leakage in the joints of tubes and drums occurred, but all serious damages were caused by some outside agent, such as collapse of the building or chimney. Table I is a compilation of the damage done to boilers.

It might be mentioned that the two Erie City boilers installed in Tsurumi reclaimed land, although their upper drums were situated very high, and therefore seemed rather susceptible to earthquakes, were intact. This was probably due to the effectiveness of the steel bracing from the upper drum to the building steelwork.

At the time of the earthquake most of the reserve steam plants were not in operation, owing to an abundant supply of water for the hydro-electric plants. However, in the Akabane steam plant of the Imperial Government Railways, one 6,000-kw. horizontal Westinghouse-Parsons type steam turbine was in operation. At the time of the first shock the machine was stopped immediately, oil for the bearings being supplied by an auxiliary pump. When the machine was later examined, it was found that a large number of the turbine blades were bent, but there was no damage done to the bearings. Another turbine of the same type, which was open for inspection at the time, was also damaged in a similar manner. It should be mentioned that the damage done to the blades may be attributed to the fact that the direction of the earthquake vibrations was along the axis of the machine's shaft.

Steam Turbine Running But Sustained No Damage

A 7,500-kw. Curtis steam turbine in the Kanagawa power station of the Tokyo Electric Light Co. was running at no load for drying the armature at the time of the earthquake. This machine was immediately stopped and was found afterward to have sustained no damage. In the Yaguchi power station of the Imperial Government Railways there were four 1,500-kw. gas-engine sets. Two were in operation, one standing still, and the remaining set dismantled for repairs. It was found that no damage was done to the machines, but the flywheel of the dismantled set fell and was broken. Machines in other steam stations were not damaged to any degree.

In the Kanagawa power station were a number of economizers in a brick flue. The flue was totally destroyed and the economizers turned over. In the Akabane power station the economizers were placed directly behind the boilers upon a solid foundation and were contained within reinforced-concrete flues. The only damages done to these economizers were a few slight leaks started. It will be noted that the former installation was somewhat out of date, while the latter was a new type and incidentally was nearly earthquake proof.

Almost all pipe lines in steam stations escaped damage, as they are generally installed so as to have a certain amount of flexibility. There were, however, some minor troubles, which required repairs. All steam piping, for which steel pipe was used, was unharmed, but in some cases where cast-iron pipe was used, for water service cracks in flanges or sometimes complete rupture occurred.

Condenser Circulating-Water Pipe Failed

In the Kanagawa station the upper part of the flange of a 20-in. suction pipe, which was installed for the condenser circulating pump, was broken at the neck, so that service was completely interrupted. This incident occurred, however, not at the time of the earthquake of Sept. 1, but at a later one on Jan. 15, 1924, which was not so severe as the former. In the latter case the turbine was running and the pipe was filled with water, while in the former it was empty. The water column in the pipe may have caused the failure. From this it is evident that such pipes should be supported by bracing or otherwise.

In this power house the boiler-feed water was supplied from the water mains of Yokohama City, which were completely interrupted. This shows that the city water mains cannot be relied upon for a feed-water supply in case of a big earthquake. In the Sumida power station the boiler-feed water is obtained from an artesian well 680 ft. deep. This well was not harmed in the least.

Tables II and III show some representative cases of damage done to chimneys. It will be seen from these tables that of the ten reinforced-concrete chimneys four were either broken or collapsed and only one of the ten was left serviceable. Almost all the steel chimneys suffered no damage.

The water channels and underground ducts for circulating water to steam plants suffered similar damage to the flumes of hydro-electric plants, subsequently referred to, but rather more severe owing to the unfavorable condition of the soil.

The damage to electrical installation in most of the generating and substations was not severe, being caused mainly by the failure of buildings and other structures. The foundations of rotating machinery are generally built upon solid rock, or otherwise strong pile work, which was a factor in preventing damage to the machinery. In some cases slight cracks were observed in the foundations, probably due to improper workmanship, but, in all cases this damage did not prevent the machinery from operating.

Hydro-Electric Units Not Damaged

In the case of the Yamura water-power station, where the buildings sustained somewhat severe damage, the generators and the water turbines were not affected, although the generating sets are of the vertical type, having a shaft about 70 ft. long. No difficulty was experienced afterward in resuming operation of these units.

The foundations of the steam-turbine units in the Akabane power stations had shown uneven settling before the earthquake. This condition was made worse by the earthquake. Almost all of the steam-electric and hydro-electric generating units in the affected area were undamaged.

Owing to the fact that transformers are usually equipped with small rollers or wheels and that in the case of the outdoor type they are placed on foundations that are not overly stable, they were more or less affected, some being completely overturned and others only slightly damaged, such as breaking water and oil pipes and conductor leads.

The transformers installed at Oku substation were found to have moved nine or ten inches, although the direction of the vibrations was at right angles to that of the wheel movement. The transformers installed in the Tot-

suka substation had moved 12 to 13 in. In this case the direction that the wheels moved in coincided with that of the vibrations. From these instances it is evident that due precaution ought to be taken to prevent any movement of transformers in case of an earthquake.

It would require much space to describe the details of the effect of the earthquake upon oil circuit breakers, disconnect switches and switching equipment in general. Where buildings containing these appliances were of the earthquake-proof type, the damage was slight. Due attention must be given to the selection of proper types of supporting material, such as fittings, insulators, bushings, etc. It is also necessary that some slack must be provided in all leads to and from switching equipment.

The damage to lightning arresters was severe, particularly those of the aluminum-cell type and the oxide-film type. Of 379 arresters of the aluminum-cell type examined, 299 were damaged, or 78 per cent. Of the oxide-film type 48 were examined and 28 were found damaged, or an average of 58 per cent. The multi-gap type was less affected, and of 352 examined 108 were damaged, or an average of 31 per cent.

In connection with the installation of storage batteries, since no attention had previously been given to provide for heavy earthquakes practically all batteries installed in the affected area were disabled. Some were either overturned, dislocated, or short-circuited, while others were completely destroyed. Very few of them could be immediately used for resuming service.

The committee examined 2,843 storage-battery cells, of which 2,073 were found damaged, or an average of 73 per cent. The batteries installed at the Tabata substation were placed on the ground floor well supported, and no damage was done to them.

The damages caused to hydro-electric installations were the result of either the earthquake directly or landslides. On Sept. 15 there was a heavy rainstorm in the affected area, which augmented the heavy damage previously done to hydraulic construction.

In the Hakone system there is one dam 60 ft. high and two 30 ft. high about the river bottom, all of masonry construction. These were not damaged, although the intensity of the earthquake in those regions was most severe.

Of the earth-filled dams that which forms the Ono reservoir in the Katsuragawa system is interesting. The dam is 120 ft. high and 900 ft. long. The slope on the wetted side is 2 : 1, while on the outside the slope is 3 : 1, having a puddle core at the center. As a result of the earthquake a number of cracks appeared running parallel with the dam. These cracks reached generally vertically downward to a considerable distance, about 50 to 70 ft. deep. They were examined by boring in the dam, but were found to be not of a serious nature. Repairs were made by filling the cracks with a mixture of clay and sand, with a proper amount of water to form ordinary mortar. The reservoir was gradually filled with water without the dam's giving any evidence of trouble.

The tunnels in the area of the Katsuragawa system and also in the Hakone system where the earthquake was most severe, were practically undamaged, although in a pressure tunnel slight cracks occurred along the inside wall. These cracks could be easily repaired by filling with cement. In many cases landslides at the entrance to the tunnel caused a complete closure. In general the open channels in the Hakone district suffered damage to such an extent that they were rendered totally useless. The damage was either cracks at the bottom of the side walls or the bottom was carried away with the landslide. In the Katsuragawa district, however, most of the open channels escaped damage, except in some cases where slight cracks appeared along the side walls. In almost all cases landslides along the channels had filled them so that they overflowed and inundated the neighboring villages.

The Odawara Electric Railway Co. used reinforced-concrete pipes for water flumes. Here the effect was so severe that the pipes were totally separated at each joint, but as the pipes were unbroken, the flumes were easily repaired.

Penstocks are usually placed on mountain slopes at a very steep angle. It was natural, therefore, that these pipe lines should suffer considerable damage from landslides. In the Katsuragawa district, however, damage was less than in the Hakone district, but in one case where the side wall of the forebay had large cracks, the penstocks and anchorage blocks were dislodged by a landslide. In this case the water rushed out from the pipe and washed away the surface of the slope and flowed into the power station.

Some of the conclusions drawn were, that steam and hydro-electric generating stations, if located in a region seriously affected by earthquakes, could not escape more or less damages, and therefore an immediate resuming of service would generally be impossible. For this reason proper precautionary measures should be taken in ordinary times to interconnect the transmission systems so that in case of an emergency one station, service could be supplied from others which are not affected.

TABLE I—DAMAGE DONE TO BOILER

Description	Number	Per Cent
Severely damaged by the falling of buildings and chimneys	13	20.6
Slightly damaged by the falling of buildings and chimneys	1	1.6
Sidewall brick of the combustion chamber broken, and steam leaked at the joints of water tubes and drums	26	41.3
Undamaged	23	36.5
Total	63	100.0

TABLE II—SUMMARY OF CHIMNEYS DAMAGED IN POWER STATIONS

Construction	Number Examined	Undamaged — Number	Undamaged — Per Cent	Broken or Destroyed — Number	Broken or Destroyed — Per Cent	Cracked or Fire-Brick-Lining Fell — Number	Cracked or Fire-Brick-Lining Fell — Per Cent
Reinforced concrete	10	1	10	4	40	5	50
Steel-plate earthquake-proof construction	7	5	72	1	14	1	14

TABLE III—DETAILS OF CHIMNEY DAMAGES IN STEAM POWER STATIONS

Station	Construction	Height Ft.	Dia. Ft.	Number Installed	Number Damaged	Remarks
Kanagawa, (Tokyo E. L. Co.)	Reinforced concrete	180	14	1	1	Broken at 71 ft. above ground
	Reinforced concrete	180	9	1	1	Horizontal crack at 117ft. above ground
	Steel, earthquake-proof	181	11.6	1	0	
Sumida (Kinugawa Hyd. El. Co.)	Reinforced concrete	151	12	2	1	Broken at 18 ft. above ground (Flue joint)
Akabane, (Imp. Gov. Railways)	Reinforced concrete	218	8	2	2	Fire-brick lining destroyed in both. One cracked at 190 ft. above ground
Yaguchi, (Imp. Gov. Railways)	Steel, earthquake-proof	125	5	1	1	Broken at 35 ft. above ground
Wakamatsu, (Tokyo E. L. Co.)	Steel, earthquake-proof	190	7.3	1	1	Crack near foundation bolts
	Steel, earthquake-proof	165	5	1	0	at cast-iron base
Hodogaya, (Fuji Cotton Spinning Co.)	Steel, earthquake-proof	90	7	1	0	.....
Kawasaki, (Keihin El. Railway Co.)	Steel, earthquake-proof	80	7.5	1	0	.....
	Steel, earthquake-proof	120	6	1	0	.....
A Station	Reinforced concrete	140	8	1	1	Horizontal crack at ⅓ of height above ground
B Station	Reinforced concrete	132	6.25	1	1	Horizontal crack at ⅓ of height above ground
B Station	Reinforced concrete	132	7.2	2	2	One broken at base, the other at ⅓ of height above ground

The Bureau of Mines has just issued a series of master packing specifications for the use of Government Departments. These specifications include diaphragm packing, asbestos high-pressure rod packing, low-pressure spiral gland packing, asbestos metallic-cloth sheet packing, and wire-insertion packing. Copies of these may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at five cents a copy. They should serve as a useful guide to operating engineers.

It is reported that Herr Flettner proposes to construct another rotor ship of 3,000 tons and with only one tower, but of greater power and stability than the "Buckau." The German authorities have issued regulations for the navigation of rotor ships.

The Foochow Electric Co., China, proposes to construct a hydro power plant of 5,000 kw. capacity on the upper reaches of the Min River. The cost is estimated at about £200,000. It is said that the river could be made to furnish 50,000 kw.

Pinchot Takes Issue with Hoover on Electric Power

Declaring that the electric companies will, in the near future, be combined into one large monopoly, Governor Pinchot, speaking before a large audience in Philadelphia last week, declared that the problem is one not only for the states but that the federal government must take a hand if the interests of the people are to be safeguarded. He disagreed sharply with Secretary Hoover, who has been contending that the problem is one for the states alone to deal with.

It will be recalled that Governor Pinchot has lately been making a number of speeches over the country in support of Giant Power and in opposition to Superpower. The former he characterizes as a plan in which the rights of the companies and the people would be safeguarded, whereas he defines Superpower as a plan inimical to public welfare.

The situation created by the defeat of all Giant Power bills in the Pennsylvania Legislature has led Governor Pinchot to attempt a partial solution through the co-ordination, under existing laws, of the activities of the several executive departments and administrative agencies of the Commonwealth. To this end he has appointed a new Giant Power Board, composed of: George W. Woodruff, Attorney General; Clyde L. King, Secretary of Commonwealth; R. Y. Stuart, Secretary of Forests and Waters; Harold Evans, Public Service Commission; Morris L. Cooke, consulting engineer; Philip P. Wells, Deputy Attorney-General (Chairman). The Governor will be an ex-officio member of the board. In addition to such administrative efforts as the board is able to make under existing authority, it will endeavor to keep the problems of Giant Power before the people.

Engineers Protest Denial of Salary Increase

According to press reports there is a possibility that a large proportion of the engineers employed by the Massachusetts Department of Public Works will resign as a protest against the action of the Finance Department in refusing to approve salary raises. Most of these engineers are receiving less than $1,800 a year.

It will be recalled that recently in Chicago the city engineers started a general three days' vacation under similar circumstances and had been out only thirty minutes when recalled at increased salaries.

Also, some 3,500 engineers employed by the City of New York are now threatening to quit as an alternative to a 25 per cent increase and as a protest against the engineers, as a class, having been ignored in the general increase of city salaries a few months ago.

No Disturbance of Bituminous Supply Likely

Few of the Washington observers expect the threat of a strike in the bituminous mines to materialize. They realize that there are some operators in both the union and non-union camps who would welcome a strike, but the belief is that the great majority of them feel that it would be a great calamity. The sacrifices made to deflate the industry under the Jacksonville agreement would be in vain if a period of high prices should ensue. The thousands of mines now closed would spring back to life. At the end of its debauch the industry would awake with more excess capacity than ever.

It also is appreciated that some of the leaders among the mine workers would welcome a strike as the only way out of an impossible situation, which otherwise spells defeat and ruin for their personal fortunes. Here also wiser counsel is likely to prevail, it is believed. The leaders must take into account the heavy losses their ranks have suffered. Practically 70 per cent of the current output of coal now is being furnished by non-union workers, as compared with 40 per cent two years ago. The situation in northern West Virginia is typical of union loss of ground.

To provoke a strike under such conditions obviously would benefit chiefly the non-union operations. The expanded non-union area can produce more than the railroads can haul away.

Klamath River Project Meeting Obstacles

California apparently is not through with the Klamath River controversy. The reservation of that stream below the Shasta as a fish and game preserve is becoming increasingly unpopular in the northern part of the state, reports from California indicate.

The Electro-Metals Co., which holds a preliminary permit for a power project on the stream, is showing no inclination to give up the fight. None will be surprised to see it go into the courts to determine whether or not the new law is retroactive.

The increasing need for power in the lower Klamath Valley is arousing new demands for the repeal of the law. This, combined with new proof that the power development need not conflict with the fish industry, apparently is paving the way for another test of strength on the matter.

Concrete Arch Dam To Be Tested to Destruction

More than $70,000 has been raised, by a special committee of the Engineering Foundation, to erect an arch dam 100 ft. high on Stevenson Creek, a tributary of the San Joaquin River, about 60 miles east of Fresno, Calif., for test purposes. Engineers of America and Europe are aiding the plan, which is attracting world interest as it is expected to test this dam to destruction. About $100,000 will be spent to determine by this method the principles of concrete-arch design.

The arch-dam investigation is being made by members of the American Society of Civil Engineers in co-operation with the United States Bureau of Reclamation, the States of California and Oregon, the City of San Francisco, Los Angeles County, power companies, irrigation districts, universities and individual engineers.

During the summer the foundation for the dam will be prepared and other initial steps taken in construction work. A number of special instruments for measuring stresses, taking temperatures and observing the slight movements of the dam during its construction and testing will be made. These instruments will be carefully tested at the Bureau of Standards of the Department of Commerce in Washington before being put into the dam.

In size the structure will actually exceed some existing arch dams, so that the results of the tests will have immediate practical utility. The local advantages will promote ease and speed of a great variety of observations. Not the least among the conditions favorable to the project are the character of engineering talent in charge of the tests and the financial support of public-utility corporations, construction companies, manufacturers and engineers.

The placing of concrete masonry is expected to begin in October. When the dam has been built to a height of 60 ft. it will be subjected to tests and observations for about one year. It is then planned to increase its height in 10-ft. steps to a total of 100 ft. At each stage the testing will be continued.

The dam is to be situated in a rough, rocky gorge in the mountains where no damage could result if it should fail under the tests. An important water supply conduit of the Southern California Edison Co. near the dam will afford the use of water as needed for the tests without dependence upon local rainfall or melting snow.

Erratum — In the Technical Papers Program for the coming convention of the N.A.S.E., page 115 of the July 21 issue, the name of Joseph F. Shadgen was inadvertently misspelled.

To Investigate Condenser Tubes

Announcement has been made of the organization of a special A.S.M.E. research committee to investigate condenser tubes. The first meeting of the special committee was held in Atlantic City on June 24, at which the scope of the work was outlined. This is to cover research on the causes of failure of copper alloy tubes in heat interchange apparatus where steam and water are handled, and will include condensers, heaters and evaporators for stationary plants. The committee will co-operate with the Prime Movers Committee of the N.E.L.A. Prof. Albert E. White, Director of the Department of Research, University of Michigan, was elected chairman and C. B. LaPage, secretary.

Largest Synchronous Motor for Steel-Mill Drive

A 9,000-hp. synchronous motor, to be installed by the McKinney Steel Co. at its River-Furnace plant, Cleveland, will have the highest continuous horsepower rating of any industrial motor in the world. This motor will be direct connected to a Morgan continuous billet mill which will probably be in operation early in 1926.

The mill will have ten stands of rolls, six of which will be 21-in. and the remainder, 18-in. The motor will be made by the General Electric Co. and will be rated at 9,000-hp., 107 r.p.m. 6,600 volts, three phase 25 cycles to operate at unity power factor. It will have a shaft extension on both ends and will be coupled to a long layshaft running the length of the mill with bevel gearing to each stand of rolls. This will be the first large steel rolling mill in the world to be driven by a synchronous motor. The usual practice has been to drive such a mill by an induction motor. The McKinney Steel Co. now has in use a Morgan mill of practically the same size but of somewhat lower speed, driven by a 5,750-hp. 40-deg. 94-r.p.m. induction motor which has been in service about nine years.

Standards for Shafting and Keys

Two important dimensional standards dealing with cold-finished shafting and square and flat shafting keys, recently approved as "Tentative American Standards" by the American Engineering Standards Committee, have just been published by the American Society of Mechanical Engineers, the sponsor, and are ready for distribution.

The sizes covered are from ½- to 6-in. (machinery shafting) and $\frac{15}{16}$- to $5\frac{15}{16}$-in. (transmission shafting). The recommended stock lengths for cold-finished shafting are 16, 20 and 24 ft. All the tolerances are negative and represent the maximum allowable variation below the exact nominal size.

The keys considered for these sixty standard shaft diameters are either square or flat. The standard widths and heights and the corresponding negative tolerances are given. The keys are to be cut from cold-finished stock and are to be used without machining.

In the development of these standards, which was begun in 1918, the whole industry, including not only manufacturers and users, but more than 300 dealers and jobbers, has participated by correspondence, conferences and representation on the sectional committee in charge. A tentative report published in 1923 was widely distributed. As a result of this a revised report was again widely circulated for criticism before final revisions were made.

Coming Conventions

American Chemical Society. Charles L. Parsons, 1709 G St., N. W. Washington. Meeting at Los Angeles, Aug. 3-8.

American Electric Railway Association. James W. Walsh, 8 West 40th St., New York City. Convention and exhibits at Young's Million Dollar Pier, Atlantic City, N. J., Oct. 5-9.

American Electrochemical Society. Dr. Colin G. Fink, Columbia University, New York City. Convention at Chattanooga, Tenn., Sept. 24-26.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Pacific Coast convention, Seattle, Wash., Sept. 15-17.

American Institute of Mining and Metallurgical Engineers. F. F. Sharpless, 29 West 39th St., New York City. Autumn Meeting at Salt Lake City, Aug. 31-Sept. 3.

American Society of Civil Engineers. George T. Seabury, 29 West 39th St., New York City. Fall meeting at Montreal, Oct. 14-16.

American Society of Mechanical Engineers—Calvin W. Rice, 29 West 39th St., New York City. Annual meeting at New York City, Nov. 30-Dec. 3.

American Society of Refrigerating Engineers, William H. Ross, 154 Nassau St., New York City. Annual meeting at New York City, Nov. 30-Dec. 3.

Association of Iron & Steel Electrical Engineers. John F. Kelly, Empire Bldg., Pittsburgh, Pa. Annual meeting at Philadelphia, Pa., Sept. 14-19.

Chemical Industries. Tenth Exposition at Grand Central Palace, New York City. Sept. 28-Oct. 3.

Electric Power Club, S. N. Clarkson, B. F. Keith Bldg., Cleveland, Ohio. Fall meeting at Briarcliff Manor, N. Y., Oct. 19-22.

Empire State Gas & Electric Association. C. H. B. Chapin, 5618 Grand Central Terminal Bldg., New York City. Meeting at Lake Placid Club, N. Y., Oct. 1 and 2.

Illuminating Engineering Society. Norman D. MacDonald, 29 West 39th St., New York City. Convention at Detroit, Mich., Sept. 14-18.

Iron and Steel Exposition. John F. Kelly, 706 Empire Bldg., Pittsburgh, Pa., Sept. 14-19. Exposition at the Philadelphia Commercial Museum, Philadelphia, Pa., Sept. 14-19.

National Association of Practical Refrigerating Engineers, Edward H. Fox, 5707 West Lake St., Chicago, Ill. Sixteenth annual convention and educational exhibition at Statler Hotel, Detroit, Mich., Dec. 8-12.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. National convention and exhibition at St. Paul, Minn., Aug. 31-Sept. 4. Annual conventions and exhibitions of state associations are scheduled as follows: **Minnesota Association** at St. Paul, Aug. 24-28. A. Nelson, 800 22nd Ave., Minneapolis, Minn.

National Exposition of Power & Mechanical Engineering. Fred W. Payne, Manager, Grand Central Palace, New York City. Exposition at Grand Central Palace, Nov. 30-Dec. 5.

National Safety Council. G. H. Cameron, 168 North Michigan Ave., Chicago, Ill. Fourteenth Annual Safety Congress at Cleveland, Ohio, Sept. 28-Oct. 2.

New England Water Works Association, Frank J. Gifford, Dedham, Mass., sec. Convention to be held aboard "Richelieu," en route Montreal to Quebec, etc., Sept. 8-11. For details apply to George E. Marsters, Inc., 248 Washington St., Boston, Mass.

Universal Craftsmen Council of Engineers. Thomas H. Jones, 33 Linden Ave., Cherrydale, Va. Twenty-third international convention in the Armory, at Akron, Ohio, August 4-8.

Obituary

Speer, John Strohm, president and general manager of the Speer Carbon Co., St. Marys, Pa., died on July 17, while playing in a golf tournament match with other members of the St. Marys Country Club against the members of the Wellsville, N. Y., Country Club. He was seized with an attack of acute heart failure and died almost instantly. Mr. Speer was born at Harmesville, Allegheny County, Pa., Jan. 4, 1859. At the age of fourteen he entered the drug business at Sharpsburg, Pa., and from that city went to Colorado and followed his profession as a druggist in the cities of Pueblo and Denver. After spending some time in Fargo, N. D., he returned to Sharpsburg and from that place went to Sandusky, Ohio, where he was affiliated with the Partridge Carbon Co. He removed to St. Marys in 1898 and established the Speer Carbon Co., which has since developed into one of the leading industries of its kind in America. This company still bears his name. He is survived by a widow and two children.

Business Notes

At a meeting of the Board of Directors of the Manning, Maxwell & Moore, Inc., on July 1, John F. Schurch was elected president of the company.

The W. N. Best Corporation, 11 Broadway, New York, manufacturer of oil burners and oil burning furnaces, announces the purchase of the Dempsey Furnace Co., Jersey City, N. J. The combined furnace business of the two companies will be operated as the Dempsey Furnace Division of the W. N. Best Corporation, and will be carried on under the personal direction of H. B. Dempsey. The W. N. Best Corporation has just completed its thirty-fifth year in the liquid-fuel business.

The Crane Co., 836 South Michigan Ave., Chicago, Ill., has been celebrating its seventieth anniversary. The *Valve World,* the house organ of the company, has published a special commemorating number which contains interesting historical and other instructive and entertaining articles. Among the pictures which are contained in this issue is one of the first Crane shop and there is also a picture of the old bell put up in 1886 that still calls the workmen to their work at old No. 10 North Jefferson St.

Trade Catalogs

Pumps and Turbines — Dean-Hill Pump Co., Anderson, Ind. Catalog No. 125 although small in size gives good descriptions of the pumps and the Wait single-stage steam turbines manufactured by the company.

Air Filters—The Cooling Tower Co., Inc., 15 John St., New York City. "Tang-l-dust" is the name of Bulletin 253, recently published, descriptive of Type "A" air filter manufactured and sold by this company. It is adequately illustrated and contains necessary specifications.

Regulators, Temperature — Atlas Valve Co., 282 South St., Newark, N. J. Bulletin No. 6 covers the Victor temperature regulators. It is well illustrated and contains tables for finding sizes of diaphragm control valves required to heat a given quantity of water in gallons per hour.

Boilers — Badenhausen Corp., 900 Victory Bldg., Philadelphia, Pa. "How Badenhausen Builds Boilers" is the title of a recent catalog published by this corporation. The process of the manufacturing of the boilers from the planing of the plate to the finished installations is illustrated by photos.

Uniflow Engines — The Fitchburg Steam Engine Co., Fitchburg, Mass. "The Fitchburg Piston Valve Uniflow Engine" is the title of a recent bulletin published by the company describing the construction and features of this engine. The bulletin is well illustrated by pictures of the various parts and also a sectioned view of the entire engine.

Switchboards—General Electric Co., Schenectady, N. Y. "Switchboards, Installation, Operation and Maintenance," is No. 87,000-E, new catalog recently published. It is illustrated with photos, tables, formulas, etc., and contains varied information of value to those engaged in the construction, installation, maintenance or operation of switchboards.

Pyrometers, Potentiometer—Leeds & Northrup Co., Philadelphia, Pa. Catalog No. 87, revised, describes the temperature indicating, temperature recording, automatic central-station, automatic control equipment, potentiometer, recording controllers, thermocouples, etc., manufactured by the company. The catalog is well illustrated and has samples of charts for instruments. Prices and sizes are included.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack:

Bituminous, Net Tons	Market Quoting	July 27, 1925
Pool 1	New York	$2.40@$2.70
Smokeless	Boston	1.59
Clearfield	Boston	1.65@ 1.95
Somerset	Boston	1.70@ 2.00
Kanawha	Columbus	1.35@ 1.50
Hocking	Columbus	1.45@ 1.70
Pittsburgh	Pittsburgh	1.90@ 2.00
Pittsburgh gas slack	Pittsburgh	1.40@ 1.60
Franklin, Ill.	Chicago	2.25@ 2.50
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.25@ 2.50
West Ky.	Louisville	1.10@ 1.25
S. E. Ky.	Louisville	1.35@ 1.75
Big Seam	Birmingham	1.50@ 2.00
Anthracite, Gross Tons		
Buckwheat No. 1.	New York	$2.00@$2.50
Buckwheat No. 1.	Philadelphia	2.15@ 2.75
Birdseye	New York	1.40@ 1.60

FUEL OIL

New York—July 30, light oil, tank-car lots; 28@34 deg. Baumé, 5½c. per gal., 36@40 deg., 5⅝c. per gal., f.o.b., Bayonne, N. J.

St. Louis—July 21, tank-car lots, f. o. b. St. Louis; 24@26 deg., $1.70 per bbl.; 26@28 deg., $1.75 per bbl.; 28@30 deg., $1.80 per bbl.; 30@32 deg., $1.85 per bbl.; 32@36 deg., gas oil, 4.8c. per gal.; 38@40 deg., 5.35c. per gal.

Pittsburgh—July 21, f.o.b. local refinery; 30@34 deg., fuel oil, 5½c. per gal.; 36@40 deg., fuel oil, 6½c. per gal.

Dallas—July 21, f.o.b. local refinery, 26@30 deg., $1.40 per bbl.

Philadelphia—July 23; 28@30 deg., $2.205@$2.268 per bbl.; 18@22 deg., $1.932@$1.985; 13@16 deg., $1.68@ $1.743 per bbl.

Boston—July 27, tank-car lots, f.o.b. heavy oil, 12@14 deg., Baumé, 4½c. per gal.; light oil, 28@32 deg. Baumé, 5½c. per gal.

Cincinnati—July 28, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5½c. per gal.; 26@30 deg., 5⅝c. per gal.; 30@32 deg., 5⅝c. per gal.

New Plant Construction

Ariz., Clifton—W. H. Rosecrans, 108 South La Salle St., Chicago, Ill., Engr., will receive bids about September 15th for the construction of a hydro-electric plant including a power house with 22,000 hp. motor wheel equipment and two 8,000 kw. generators, etc. for Commonwealth Power & Light Corporation of Arizona. Estimated cost $2,000,000.

Ariz., Inspiration—Anaconda Copper Co., 25 Broadway, New York, Pur. Agt., is receiving bids for 36 acid pumps 100 to 1,800 g.p.m. capacity against a 10 to 125 ft. head, with electric motors, starting equipment, etc. for Inspiration Construction Copper Co., plant here. G. H. Booth, is engineer.

Calif., Los Angeles—H. H. Abernathy, Wilcox Ave. and Hollywood Blvd., is receiving bids for the construction of a 14 story apartment including steam heating and refrigeration systems at 655 La Brea Ave. Estimated cost $700,000. L. L. Jones, 602 Grosse Bldg., is architect.

Calif., Los Angeles — Harris-Neumark Estate, c/o Curlett & Beelman, Union Bank Bldg., awarded contract for the construction of a 12 story loft building at 9th and Los Angeles Sts. to Baruch Corporation, I. W. Hellman Bldg. $55,000. Klein-Norton Co., 253 South Los Angeles St., is lessee.

Calif., Los Angeles — M. H. Hellman, J. Toplitzky and associates, are having plans prepared for the construction of a 12 story hotel including steam heating system at West 7th and Bixel Sts. Estimated cost $4,500,000. Shultyze & Weaver, Pacific Mutual Bldg., are architects.

Calif., Los Angeles—Warner Bros., J. Toplitsky, H. W. Hellman Bldg., is having preliminary plans prepared for the construction of a 4 story theatre and office building including steam heating and ventilating systems at Wilcox Ave. and Hollywood Blvd. Estimated cost $1,250,000. G. A. Landsburgh, 700 Hill Street Bldg., is architect.

Calif., Los Angeles — F. Webster, 922 Hollywood Guaranty Bldg., plans the construction of a 12 story bank and office building at 1st St. and Broadway. Estimated cost $750,000.

Calif., Oakland — East Bay Municipal Utility Dist., Ray Bldg., 1924 Broadway, will extend bids to September 4th for the construction of a 350 ft. dam to impound the waters of the Mokelumne River, near Lancha Plana pumping plant, with auxiliaries, aqueduct, etc. J. H. Kimball, is secretary.

Calif., Oroville—Union Ice Co., V. E. Bonnefoy, representative, plans the construction of an ice plant at High and Pine Sts. Estimated cost $75,000 to $100,000.

Calif., San Francisco—A. I. Esberg, 216 Pine St., plans the construction of a 20 story office building at Montgomery and Sutter Sts. Estimated cost $1,000,000. Architect not selected.

Calif., San Francisco—St. Mary's Hospital, Hayes and Stanyan Sts., is having plans prepared for the construction of a 5 story hospital annex on Hayes St. Estimated cost $800,000. Shea & Shea, 454 Montgomery St., are architects.

Calif., San Jose—Bank of Italy, Bank of Italy Bldg., San Francisco, plans the construction of a 12 story bank and office building at 1st and Santa Clara Sts., here. Estimated cost $850,000. H. A. Minton, Bank of Italy Bldg., San Francisco, is architect.

Fla., Lakeland—H. Concad, awarded contract for the construction of an 8 story hotel at Massachusetts and Lemon Sts. to Livering, Longbotham, St. Petersburg. $836,000.

Fla., Tampa—Gillett Apartments, Inc., H. C. Allen, Secy., plans the construction of a 10 story apartment at Crescent Plaza and N. B. St. Estimated cost $600,000.

Ga., Alto—State awarded contract for the construction of a 4 story State Tuberculosis Hospital to C. H. Van Ormer, Healy Bldg., Atlanta. Estimated cost $500,000.

Ill., Chicago—Aquarium Society, M. A. Traylor, Pres., 38 South Dearborn St., will soon receive bids for the construction of an aquarium at Lake Front Park. Estimated cost $2,000,000. Graham, Anderson, Probst & White, 80 East Jackson St., are architects.

Ill., Chicago — Leichenko & Esser, 38 South Dearborn St., Archt., will soon award contract for the construction of a 3 story hotel and bath house. Pumps and filters for swimming pool will be purchased. Estimated cost $500,000. Owner's name withheld.

Ill., Chicago—L. Guenzel, 879 North State St., Archt., will soon receive bids for the construction of a 19 story hotel including 2 passenger and 1 freight elevators at Cass Ave. and Delaware St. for Eitel-Decker Hotel Corporation. Estimated cost $1,600,000. Architect will purchase steam heating system.

Ind., Indianapolis — Supreme Lodge Knights of Pythias, Indiana Pythian Bldg., plans the construction of a 3 story lodge building on Meridian St. Estimated cost $500,000. McGuire & Shook, Pythian Bldg., are architects.

Kan., Concordia—City will soon receive bids for the construction of a new deep well, pumping plant, etc. Estimated cost $100,000. C. A. Haskins, 824 Finance Bldg., Kansas City, Mo., is engineer.

Kan., Greensburg—City plans improvements to electric light plant and distribution system. Estimated cost $50,000. Work will be done by day labor.

Kan., Sylvan Grove—City is having preliminary plans prepared for the construction of a new deep well, pumping equipment, etc. Estimated cost $12,500 to $15,000. C. A. Haskins, 824 Finance Bldg., Kansas City, Mo., is engineer.

Kan., Wichita—Edith Rockefeller Trust Co., Chicago, Ill., will soon award contract for the construction of a 14 story Union National Bank Building here. Estimated cost $2,000,000. H. M. Vitzhurn, 307 North Michigan Ave., Chicago, Ill., is architect.

La., New Orleans—New Orleans and Chicago syndicate, is having plans prepared for the construction of a 16 story office and store building at Baronne and Common Sts. Estimated cost $2,000,000. S. S. Joy, 2001 West Pershing St., is architect.

La., Shrewsbury — Jefferson Drainage Board, awarded contract for the construction of 4 pumping stations 850,000 g.p.m. capacity each to A. M. Lockett & Co., 521 Baronne St., New Orleans. $535,636.

Md., Salisbury — Salisbury Water and Sewer Comn., C. E. Harper, Chn., will receive bids until Aug. 20th for 6 centrifugal pumps, 1,000 to 2,500 g.p.m. capacity, with motors, pumping equipment, etc. F. H. Dryden is chief engineer.

Mass., Boston—E. N. Wyner, 18 Tremont St., plans the construction of a 10 story hotel at Newbury and Arlington Sts. Estimated cost $2,000,000. Strickland, Blodgett & Law, 26 Pemberton Square, are architects.

Mass., Cambridge (Boston P. O.)—J. J. Shine, 1374 Massachusetts Ave. plans the construction of a 6 story apartment hotel at Garden and Berkeley Sts. Estimated cost $500,000. Architect not selected.

Mass., Great Barrington—Fairview Hotel, c/o Crow, Lewis & Wick, 200 5th Ave., New York, Archts., plans the construction of a hotel here. Estimated cost $500,000.

Mass., Somerville (Boston, P. O.)—Ford Motor Co., Woodward Ave., Highland Park, Mich., will soon award contract for the construction of a 2 story power house including three 500 hp. boilers, three 500 kw. turbines, 2 pumps, etc. on Middlesex Ave., for assembly plant, here. A. Kahn, 1000 Marquette Bldg., Detroit, Mich., is architect.

Mich., Detroit—Supt. of Lighthouses, 900 Lawyers Bldg., will receive bids until August 14th for 2 oil engine-driven air-compressing outfits 225 cu.ft. per minute capacity.

Mich., Muskegon—Shaw Walker Co., will receive bids about August 1st for remodeling power plant including new boiler feed pump and 300 hp. water tube boiler for powdered fuel. Estimated cost $50,000. Woodmansee-Davidson Engineering Co., 208 South La Salle St., Chicago, is engineer.

Minn., Minneapolis—E. Quinlan Realty Co., 513 Nicollet Ave., awarded contract for the construction of a store to J. Leck Co., 211 South 11th St. Estimated cost $1,000,000.

Mo., St. Louis—Bd. of Public Service, 208 City Hall, will receive bids until August 25th for 4 water tube boilers and 4 forced draft chain grate stokers for High Service Station No. 2 at Bissell's Point. Estimated cost $90,000. E. E. Wall is director.

Mo., St. Louis—Burkhart Mfg. Co., 4900 North Second St., is in the market for a 25 to 50 kva. a.c. direct connected generator.

Mo., Warrensburg — Roseland Farm & Mfg. Co., is receiving bids for the construction of a 2 story cold storage plant. Estimated cost $45,000. C. A. Smith, Finance Bldg., Kansas City, is architect.

Neb., Omaha—A. H. Blank Theatre Co., c/o M. B. Griffin, 1107 First National Bldg., is having preliminary plans prepared for the construction of a theatre building at Farnam and 20th Sts. Estimated cost $1,000,000. J. Eberson Co., 212 East Superior St., Chicago, Ill., is architect.

Neb., Omaha—World Realty Co., 1506 Douglas St., plans the construction of an 8 story theatre building at 16th and Douglas Sts. Estimated cost $1,000,000.

N. J., Edgewater—Palm-Olive Co., 360 North Michigan Ave., Chicago, Ill., has had plans prepared for the construction of an oil handling plant including steam pumps, air compressor and 150 hp. boiler house, etc. Estimated cost $200,000. Lockwood Greene & Co., 400 North Michigan Ave., Chicago, are engineers.

N. J., Newark—W. Lowenstein, 132 West 43rd St., is having plans prepared for the construction of a 12 story office building at 776 Broad St. Estimated cost $500,000. L. A. Abramson, 48 West 46th St., New York City is architect.

N. Y., Jamestown—City awarded contract for extension to lighting plant on Steele St. to C. Haas, Monroe and 10th Sts. $100,000.

N. Y., New York—Brodsky & Klosk, c/o Springsteen & Goldhammer, 32 Union Square, Archts. and Engrs., are having plans prepared for the construction of a 5-story apartment on Castle Hill Ave. Estimated cost, $600,000.

N. Y., New York—City, H. Bruckner, Boro. Pres., Borough Hall, will receive bids until August 5th for the construction of a municipal building including steam heating system at Walton, Gerard Aves. and 167th and 168th Sts. Estimated cost $3,200,000. C. B. Meyers, 31 Union Square, is architect and engineer.

N. Y., New York—Department of Plant and Structures, Municipal Bldg., awarded contract for the construction of a boiler plant at Sixteenth St. and Avenue C to Velodrome Heating Co., 160 East 144th St., $39,000.

N. Y., New York—L. Gerbins, c/o Schwartz & Gross, 347 Fifth Ave., Archts. and Engrs., is having plans prepared for the construction of a 16-story hotel at 257 West 92nd St. Estimated cost, $1,500,000.

N. Y., New York — S. Hoffman, c/o Schwartz & Gross, 347 5th Ave., archts. and engrs., is having plans prepared for the construction of a 15 story apartment at 77th St and Amsterdam Ave. Estimated cost $1,000,000.

N. Y., New York — I. Hohauser, 1400 Broadway, Archt. and Engr., is preparing plans for the construction of an 18 story apartment on West 86th St. Estimated cost $1,200,000. Owner's name withheld.

N. Y., New York—New York University, 32 Waverly Place, is having plans prepared for the construction of a 15 story addition to college at Washington Square and 4th St. Estimated cost $3,000,000. McKim, Mead & White, 101 Park Ave., are architects.

N. Y., New York—Shreve & Lamb, 52 Vanderbilt Ave., Archts., are preparing plans for the construction of a 5 story apartment at 89th St. and 1st Ave. Estimated cost $500,000. Owner's name withheld.

N. Y., Raybrook—F. R. Utter, Supt. of Purchase, Capital, Albany, will receive bids until August 10th for the construction of an electric elevator, storehouse and cold storage building for New York State Hospital, here. Private plans.

N. C., Charlotte—First National Bank, 20 South Tryon St., plans the construction of a 20 story office building. Estimated cost $1,000,000. L. Asbury, Realty Bldg., and Lockwood Greene & Co., Piedmont Bldg., are architects.

O., Cleveland—A. C. Bishop, Guardian Bldg., is in the market for refrigeration and ice making machinery.

O., Cleveland—Brotherhood of Locomotive Trainmen, B. Robertson, Pres., Guardian Bldg., plans the construction of a 10 story office building. Estimate cost $1,000,000. Architect not selected.

O., Cleveland—Ohio Bell Telephone Co., c/o G. A. Kositsky, 4300 Euclid Ave., is in the market for a 35-hp. Foos gas engine for Brookly Telephone Exchange.

Okla., Bethany—City plans the construction of a new waterworks system including a well, motor driven pumps, etc. Estimated cost $40,000. H. E. Mussen, Grain Exchange Bldg., Oklahoma City, is engineer.

Okla., Duncan—City will soon receive bids for the construction of 7 new wells, additional power unit, mains, etc. Estimated cost $100,000. Private plans.

Okla., Fargo—City is having preliminary plans prepared for the construction of a new waterworks system including pump, tank on tower, etc. Estimated cost, $15,000. Engineer not selected.

Okla., Haleyville—Southern Utilities Co., is having preliminary plans prepared for the construction of a 20 ton distilled water, ice plant. Estimated cost $40,000. S. M. Makers, is engineer.

Okla., Idabel—W. O. Campbell, Clk., will receive bids until August 18th for the construction of a new 500,000 g.p.d. filter plant including motor driven centrifugal pumps, pumping equipment, 100 hp. oil engine, etc. Estimated cost $50,000. V. V. Long & Co., 1300 Colcord Bldg., Oklahoma City, are engineers.

Okla., Okewah—J. S. Price, Clk., will receive bids until August 7th for the construction of a new 1,000,000 gal. filter plant including a pumping station, 3 motor driven centrifugal pumps, two tanks on tower, etc. Estimated cost $200,000. V. V. Long & Co., Colcord Bldg., Oklahoma City, are engineers.

Okla., Tulsa—H. J. and A. Sophian, Sophian Plaza Bldg., Kansas City, Mo., plans to construction of an 8 story apartment on 15th St. here. Estimated cost $1,000,000. Shepard & Wiser, R. A. Long Bldg., Kansas City Mo., are architects.

Pa., Philadelphia — Kunock Co., 1034 Spruce St., awarded contract for the construction of a 4 story apartment at 4th and Chestnut Sts. to B. A. Kaplan, 1034 Spruce St. Estimated cost $500,000.

Pa., Philadelphia—Charles Lennig & Co., 40 North Front St., awarded contract for the construction of a power house at Richmond and Kennedy Sts. to Smith-Hardican Co., 1809 Callowhill St.

Pa., Philadelphia — Maryland Casualty Co., 324 Walnut St., awarded contract for the construction of a 6 story office building at 312-322 Walnut St. to William Steele & Sons Co., 219 North Broad St. Estimated cost $500,000.

R. I., Providence—Narragansett Electric Light Co., Eddy St., awarded contract for the construction of a power plant including a boiler house on Eddy St. to R. H. Baker, 304 Main St., Cambridge, Mass.

S. C., Spartanburg—Taylor-Colquitt Co., Easley, plans the construction of a creosoting plant including vacuum and compression pumps with motor drive, here. Estimated cost $200,000.

Tenn., Nashville—J. T. Blair, 517 Commerce St., plans the construction of an 8-story apartment at 6th and Commerce Sts. Estimated cost $750,000.

Tex., El Paso—C. A. & A. C. DeGroff, awarded contract for the construction of an 11 story hotel to Remey Bros., Caples Bldg. Estimated cost $1,000,000.

Tex., Jayton — Montgomery & Ward, Wichita Falls, Engrs., will receive bids until August 20th for the construction of a waterworks system including pumping equipment, etc., for city. Estimated cost $60,000.

Tex., Nederland—Eastern Texas Electric Co., plans the construction of an ice and power plant. Estimated cost $40,000. Engineer not selected.

Tex., San Antonio—S. L. Jeffers, 1 Bushnell Place, awarded contract for the construction of two 12 story hotels at Avenue E. and 3rd St. to General Construction Co., 607 Nogalitos St. Estimated cost $650,000 and $700,000 respectively.

Va., Richmond—The Southside Virginia Power Co., South Boston, I. Vaughan, plans the construction of a hydro-electric plant on the Meherrin River, Dan River or Staunton River near here. Estimated cost $300,000 to $500,000.

Wis., Milwaukee — Milwaukee Electric Railway & Light Co., Public Service Bldg., is having plans prepared for the construction of a 2 story addition to electric generating plant including a 30,000 kw. unit on Lakeside St. F. Luber, c/o owner, is architect. J. Anderson, c/o owner, is engineer.

Ont., Welland—Bd. of Water Commissioners, awarded general contract for the construction of a 6,000,000 g.p.d. filtration plant, etc., to W. H. Yates Construction Co., 17 Main St., East Hamilton. Estimated cost $300,000. Pumps and filter equipment will be purchased.

Que., Portneuf—Portneuf Power Co., W. F. Mackalairer, Director, 849 Lorne Crescent St., Montreal, is having plans prepared for a 1,000,000 hp. development here.

Australia, Melbourne—State Electricity Comn. of Victoria, 39 William St., will receive bids until September 21st for three 250-kva., 22,000, 115-, 240-v., 3-ph., 50-cy., oil-insulated, self-cooled outdoor type transformers.

Australia, Melbourne—Victorian Government Railways will receive bids until September 16th for three pneumatic power hammers with motor, tools and accessories, three compressed air or steam hammers with tools and accessories.

Honolulu—Wakiki Beach—Hawaii Holding Corporation, awarded contract for the construction of a 6 story hotel at Wakiki Beach to H. E. Ketchum, Pacific South West Bldg., Long Beach, Calif. $500,000. Steam heating system will be purchased.